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AUTHOR Schramm, C.; Osland, Walt
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ABSTRACT

One of twelve individualized courses included in an automotive repair curriculum, this course covers the theory, diagnosis, repair, and adjustment of automotive electrical systems. The course is comprised of six units: (1) Fundamentals of Electrical Systems, (2) Battery Servicing, (3) Starting Systems, (4) Charging Systems, (5) Ignition Systems, and (6) Lighting Systems. Each unit begins with a Unit Learning Experience Guide that gives directions for unit completion. The remainder of the unit consists of Learning Activity Packages (LAP) that provide specific information for completion of a learning activity. Each LAP is comprised of the following parts: objective, evaluation procedure, resources, procedure, supplemental sheets, study guide, and a LAP test with answers. The course is preceded by a pretest which is designed to direct the student to units and performance activities. (LRA)

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MOUNTAIN PLAINS LEARNING EXPERIENCE GUIDE:
Automotive Repair.

Course: Electrical Systems.

CE 027771

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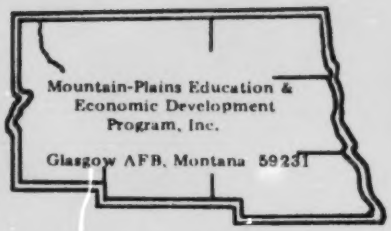

Learning Experience Guide

COURSE: ELECTRICAL SYSTEMS

DESCRIPTION:

Electrical Systems covers the theory, diagnoses, repair and adjustment of automotive electrical systems.

RATIONALE:

The theory and techniques covered in this course will enable you to analyze and test, repair and adjust components to restore automotive electrical systems to manufacturer's specifications.

PREREQUISITES:

37.03.00.00 Parts & Accessories

OBJECTIVES:

Inspect, service and repair automotive electrical systems.

RESOURCES:

A resource list is attached.

GENERAL INSTRUCTIONS:

This course has six units. Each unit has a Unit Learning Experience Guide (LEG) that gives directions for unit completion. Each unit consists of Learning Activity Packages (LAPs) that provide specific information for completion of a learning activity. Pretesting results direct the student to units and performance activities.

The general procedure for this course is as follows:

(1) Read the assigned unit LEG for this course.
(2) Begin and complete the first assigned LAP.
    a. Take and score the LAP test.
    b. Turn in the LAP test answer sheet.
    c. Determine the reason for any missed items on the LAP test.
    d. Proceed to the next assigned LAP in the unit.
    e. Complete all required LAPs for the unit by following steps (a) through (d).
(3) Take the unit tests as described in the Unit LEG "Evaluation Procedures".

Principal Author(s): C. Schramm/W. Osland

(4) Proceed to the next assigned unit in this course.
(5) Follow steps 1 through 4 for all required units for this course.
(6) Proceed to the next assigned course..

You will work independently unless directed to do otherwise. When questions or problems arise, you are expected to discuss them with the instructor. At all times remember to follow correct safety procedures during the performance activity.

UNIT TITLES:

.01 Fundamentals of Electrical Systems
.02 Battery Servicing
.03 Starting Systems
.04 Charging Systems
.05 Ignition Systems
.06 Lighting Systems

EVALUATION PROCEDURE:

Course evaluation is by pre and post testing using a multiple-choice type of test.

In this course, the course test is used as a pretest to determine which units, if any, the student may be able to validate. The student is considered validated for a particular unit if 4 out of 5 items are correctly answered for each LAP part on the course pretest and that particular unit does not have a performance test requirement.

For those units with performance test requirements, the student must also satisfactorily complete the performance test to validate that unit. Unit performance tests validation procedures are given in the "Evaluation Procedure" section of the unit Learning Experience Guide (LEG)

The course test will also be taken by the student as a post test to determine any changes resulting from taking all or part of the course.

FOLLOW-THROUGH:

Go to the first assigned Unit Learning Experience Guide (LEG) listed on your Student Progress Record (SPR).

RESOURCE LIST

Printed Materials

1. Automotive Encyclopedia. Motor Services.
2. Auto Mechanics Fundamentals. Martin W. Stockel, Goodheart-Willcox Company, Inc., 1974.
3. Auto Service and Repair. Martin W. Stockel, Goodheart-Willcox Company, Inc., 1975.
4. Motor's Auto Repair Manual. Motor, The Hearst Corporation. 1972 or equivalent.
5. Operator's Manuals for test equipment.

Audio/Visuals

Super 8 Sound Films:

DCA Educational Products, Inc.

1. Alternator Testing Procedures, Part I (FAA292).
2. Alternator Testing Procedures, Part II (FAA302).
3. Charge-Volts Test (FAA272).
4. Load Test (FAA262).
5. Starter Current Draw Test (FAA282).

Universal Education and Visual Arts

1. Assembling the Alternator (#7816).
2. Assembling Rotor to Frame and Pulley (#7815).
3. Assembling the Alternator (#7781).
4. Installing the Drive End Bearing (#7788).
5. Installing the Slip Ring End Bearing (#7812).
6. Removing the Drive End Bearing (#7787).
7. Removing Slip Ring End Bearing (#7811).
8. Removing the Pulley (#7782).
9. Removing the Rotor (#7783).
10. Replacing Brushes (#7814).
11. Replacing a Diode (#7813).
12. So Your Engine Won't Start (#7969).
13. Testing Diodes (#7785).
14. Testing the Stator and Rotor (#7784).
15. The Magneto (#7970).
16. Using the Diode Test (#7786).

Equipment

1. Automobiles needing: headlight and parking light repair.
   instrument light repair.
   starting wiring system checked.
   tail light or brake light repair.
2. Automobiles with: battery needing service.
   defective alternator.
   functioning charging system.
   defective generator.
   ignition system with defective starter.
   defective voltage regulator.

3. AVT Systems Super 8 mm Instant Film Loop Player.
4. Replacement Parts: electrical system.
5. Supplies: baking soda and water
   battery connection cleaner
   sand paper
   seat cover towel
6. Tools, Basic Hand: Chisel and Punch Set
   5/32" Pin Punch
   3/16" Solid

   Gauge, feeler (.002" - .025")

   Hammer, ball peen
   Hammer, plastic tip
   Handle, speed
   Hex Key Set

   Pliers, diagonal cutting
   Pliers, needle nose

   Scraper, gasket
   Screwdriver, standard (Set)
   Screwdriver, phillips (Set)
   Screw starter

   Socket Set (3/8" drive)
   extension (3")
   ratchet

   Socket Set (1/4" drive)
   extension (3")
   handle (6" flex)
   ratchet

   Socket, spark plug
   extension (6")
   Wrench, combination (Set)
   Wrench, combination ignition (Set)

7. Tools, general: fender covers
8. Tools, electrical system: alternator
   battery
   battery cable puller
   battery charger
   charging system
   circuit tester
   generator
   jumper cables
   starter
   test equipment
   voltage regulator

Student: _____ File Code: 37.04.00.00.B1-2

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Glasgow AFB, Montana 59231

COURSE PRE/POST: ELECTRICAL SYSTEMS

37.04.01.01

The term magnetic line of force is used to describe:

a. the invisible magnetic force involved in a field.
b. the reaction of charging a battery.
c. the continuity of a circuit.
d. why a light bulb will light up through a filament.

2. In order to obtain a reading on an ammeter it must be connected in:

a. a series circuit.
b. a resistance circuit.
c. OHM circuit.
d. a parallel circuit.

3. The accepted theory regarding electricity is termed:

a. OHM's Law.
b. Newton's Law.
c. Law of Energy.
d. Electron Theory

4. The diagram* represents:

a. electricity is removed.
b. energy in reserve.
c. OHM's Law.
d. Law of Eminent Ions.

5. The negative area of a flow of electricity can be determined by:

a. the excess number of electrons in an area.
b. the shortage of electrons in an area.
c. the way the magnetic field is turning, right or left.
d. what matter the electricity is made of.

37.04.02.01

6. Surplus electrons flow out of a battery from:

a. positive to negative.
b. positive to positive.
c. negative to negative.
d. negative to positive.

*(Adapted from Auto Mechanics Fundamentals, Stockel, Goodheart-Wilcox, 1975, p. 317).

37.04.02.01 (continued)

7. If battery acid is accidentally splashed on clothing or skin, one should flush the affected area with:

   a. soap and water only.
   b. water only.
   c. sulfuric acid.
   d. large amounts of water and then a mixture of baking soda and water.

8. Electricity flows out of a battery from:

   a. positive to negative.
   b. positive to positive.
   c. negative to positive.
   d. negative to negative.

9. Battery acid will burn skin, clothes, and even steel; therefore, if you spill some, it is best to wash the area with:

   a. coke.
   b. water.
   c. baking soda.
   d. sulfuric acid.

10. An automobile battery is constructed of:

   a. 1 or 4 elements.
   b. 3 or 6 elements.
   c. 2 or 5 elements.
   d. 4 or 7 elements.

37.04.02.02

11. The function of the foltmeter in conjunction to a battery is:

   a. to check for cracks in the battery casing.
   b. to check cell voltages.
   c. to check how much water is in a battery.
   d. to check to see if positive lead is concurrent to negative load.

12. Electrolyte temperature for fast charging must not exceed:

   a. 160 degrees F.
   b. 212 degrees F.
   c. 100 degrees F.
   d. 125 degrees F.

13. A battery should be recharged when the hydrometer reads:

   a. less than 75%
   b. less than 85%
   c. more than 85%
   d. less than 100%

14. You should be careful when charging a battery because it could:

    a. blow up if it is exposed to an open flame.
    b. destroy the alternator or regulator if charged too long.
    c. corrosion may occur if charged too much.
    d. transistorize the cells in the battery if charged too long.

15. It is best to remove cables from the battery with:

    a. a cable puller.
    b. anything that is available.
    c. a slip joint pliers for maneuverability.
    d. a screwdriver, so you can split the cable.

37.04.02.03

16. A specific gravity test measures the electrolyte in a battery and:

    a. tells you how warm or how cold your battery is.
    b. tells you how much G-force you have.
    c. determines the approximate state of charge.
    d. tells you how much pure water you have in the battery.

17. Fast charging sends a relatively heavy initial current of:

    a. 50-60 amps for 12 volt batteries.
    b. 90-100 amps for 12 volt batteries.
    c. 10-20 amps for 12 volt batteries.
    d. not over 25 amps for a 12 volt battery.

18. Before removing and testing a battery you should:

    a. wash it off with water only.
    b. see if the battery has any charge.
    c. check the electrolyte.
    d. clean battery with baking soda and water.

19. When checking specific gravity, you should:

    a. never check it when it is below 32 degrees F.
    b. add water so all of the cells are full.
    c. never add water before checking it.
    d. never check it while it is in the car.

20. Slow charging passes a relatively small amount of current of:

    a. 8-10 amps.
    b. 5-7 amps.
    c. 1 amp per hour only.
    d. 1-2 amps.

37.04.03.01

21. The horn relay is connected into the horn and the battery circuit in order to:

    a. make a more direct contact.
    b. raise the resistance.
    c. burn out horn diaphram by having too much current.
    d. bypass the variable resistance.

22. Voltage loss is also called:

    a. I R drop.
    b. heat loss.
    c. reducing ARC.
    d. decreased resistance.

23. When aiming a sealed beam head lamp, what does the adjustment at the top of the retaining ring control?

    a. neither horizontal nor vertical control.
    b. vertical control of beam.
    c. horizontal control of beam.
    d. both horizontal and vertical control to some degree.

24. What is the permissible voltage drop between the battery and the lamp?

    a. 0.3 volts.
    b. 12 volts.
    c. 0.6 volts.
    d. 1.0 volts.

25. How is the light output of a sealed beam headlight affected by age?

    a. stays the same.
    b. improves with age.
    c. not seriously affected.
    d. decreases rapidly.

37.04.03.02

26. When adjusting your headlights, your car must be how far from the test wall?

    a. 25 feet.
    b. 6 feet.
    c. 50 feet.
    d. 30 feet.

27. When adjusting no. 2 beam, your lights are adjusted:

    a. lower and to the right of the high beam.
    b. lower and to the left of the high beam.
    c. lower and each light is pointed outward on right and left side.
    d. directly under the high beam.

37.04.03.02 (continued)

28. When adjusting no. 1 headlights on a four bulb car (using a wall chart), you much:

    a. cover no. 2 headlights.
    b. align your front-end.
    c. have car running.
    d. be in a dark room so lights show up on wall.

37.04.03.03

29. If only one unit fails on the brake lights, it would indicate:

    a. the fuse was burned out.
    b. there is no current to both taillights.
    c. the park light is bad because it works in a series circuit.
    d. the bulb was open.

30. When checking taillights and you have none, you should check:

    a. relays.
    b. wires.
    c. bulbs.
    d. fuses.

37.04.03.04

31. To remove the directional signal lever, you must:

    a. place in left turn direction.
    b. place in neutral position.
    c. use a pulley puller.
    d. consult service manual on proper procedure.

32. How many filaments are in a taillight?

    a. none
    b. 3
    c. 1
    d. 2

33. If there is a total loss of turn signal lights, you should:

    a. check your battery.
    b. check connection on taillight.
    c. check bulbs.
    d. check fuse.

37.04.03.05

34. The instrument lights' wiring is:

    a. hooked individually to instruments.
    b. not color coded.
    c. color coded for easy installation.
    d. connected directly to the battery terminal on the coil.

37.04.03.05 (continued)

35. If only one part of an instrument panel does not light up, it could indicate a(n):

    a. bad bulb.
    b. bad rheostat control.
    c. bad fuse.
    d. inaccurate gauge.

37.04.04.01

36. By placing a soft iron core inside the coils of wire carrying an electric current you will make:

    a. an electric mtor.
    b. an electromagnet.
    c. an electrocardiogram.
    d. a generator.

37. An armature in a generator is run by:

    a. a V-belt from the crankshaft pulley.
    b. DC current.
    c. electromagnetic force.
    d. electricity.

38. If a wire in a magnetic field is part of a closed circuit, current will:

    a. not flow.
    b. ground out.
    c. destroy the wiring system.
    d. flow in a circle.

39. The more windings a generator has the more:

    a. voltage you will have.
    b. relays you will need in the generator.
    c. regulators you will need.
    d. holding capacity you will need for your battery.

40. What happens when a wire passes through a magnetic field?

    a. voltage is induced in the wire.
    b. the segments of the commutator will break down.
    c. the wire will become hot and melt.
    d. it will change its properties of make-up.

37.04.04.02

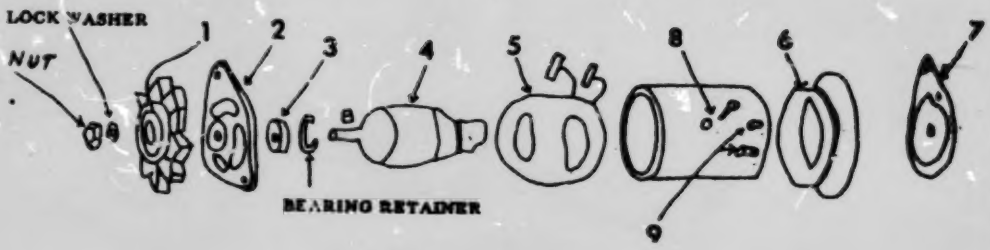
41. A generator produces voltage and:

    a. DC current only.
    b. AC current only.
    c. carbon crystals which change into DC current.
    d. AC or DC current.

37.04.04.02 (continued)

42. What is number 5 in the diagram:

    a. armature.
    b. regulator.
    c. field coils.
    d. commutator.



43. What is number 9 in the diagram above:

    a. armature.
    b. brushes.
    c. through bolt.
    d. "field" terminal.

44. What is number 6 in the diagram above:

    a. end plate rear.
    b. commutator.
    c. end plate front.
    d. dust shield.

45. What is number 8 in the diagram above:

    a. field coils.
    b. oiler.
    c. dust cover.
    d. field pole shoe screw.

37.04.04.03

46. To test field coils you would use:

    a. an ommeter.
    b. a growler.
    c. a hydrometer.
    d. a voltmeter.

47. When you test an armature for grounds, you place one test light prod on the armature core and the other on:

    a. the frame.
    b. one of the brushes.
    c. the armature terminal.
    d. the commutator bar.

37.04.04.03 (continued)

48. In cleaning armature, brushes, and field coils you:

a. wash in solvent.
b. don't clean.
c. wipe with a clean cloth.
d. wash in gasoline.

49. The two methods used for grounding the generator field circuits are:

a. A and B circuits.
b. alternator and generator.
c. AL and AC circuits.
d. AC and DC circuits.

50. Brush howl in a DC generator can result from:

a. an out-of-round commutator.
b. loose brush connections.
c. a worn armature.
d. worn field coils.

37.04.04.04

51. Cars equipped with alternator use:

a. direct current.
b. less electricity because current flows only 1/2 the time.
c. either current depending on how the voltage regulator is set.
d. alternating current.

52. A transistor voltage regulator:

a. uses no capacitor.
b. has no diodes.
c. has no moving parts.
d. has no resistance to electric flow.

53. Before making any tests on the alternator, you should:

a. unplug test equipment.
b. turn ignition switch on to open all circuits.
c. disconnect the battery ground cable.
d. have alternator out of the car.

54. Even though the alternator is turning over, in order to test an alternator, it must be connected to the:

a. capacitor.
b. battery.
c. voltage regulator.
d. heat sink.

37.04.04.04 (continued)

55. alternators in automobiles are:

a. four phase AC circuits.
b. one phase AC circuits.
c. three phase AC circuits.
d. two phase AC circuits.

37.04.04.05

56. In a motorola alternator how many leads are there in a stator?

a. 2
b. 6
c. 4
d. 3

57. To remove the heat sink and insulator on an alternator, you:

a. separate the three stator load wires to prevent shorting.
b. remove with a pulley-puller.
c. remove DC output terminal nuts and remove terminal.
d. remove the heat sink diodes first.

58. A diode, in an alternator, has inside it:

a. a thin loop of carbon.
b. a small resistor.
c. a thin silicon wafer.
d. small contact points.

59. When splitting stator from alternator, to prevent damage to stator windings, you should not insert screwdriver more than:

a. 1/4 inch.
b. 1/2 inch.
c. 1/16 inch.
d. 1/8 inch.

60. In a field circuit resistance test, when testing each connection along the circuit you get a drop in voltage, this could indicate:

a. a low output from the battery.
b. a loose or corroded connection.
c. a bad voltage regulator.
d. a bad stator.

37.04.04.06

61. The most commonly used voltage regulators has how many separate control units:

a. 3
b. 4
c. 1
d. 2

37.04.04.06 (continued)

62. Diode rectifiers in a single unit voltage regulator prevent current flow back into the:

a. field terminals.
b. battery.
c. junction block.
d. alternator.

63. In a voltage regulator, the electromagnet with the:

a. fine wire controls current, heavy wire controls voltage.
b. fine wire controls voltage, heavy wire controls current.
c. fewest loops or turns controls voltage, fine wire protects battery.
d. fewest loops or turns controls current, fine wire controls voltage.

64. Voltage regulators operate on the principle:

a. of electromagnetic force.
b. that high voltage fills up the core making contact with ground.
c. of increasing length of current making room for overflow of electricity.
d. that high current causes a tipped-down armature and therefore grounds it.

65. The difference between a double contact voltage regulator and a single contact voltage regulator is:

a. longer service with higher generator output.
b. shorter service with lower generator output.
c. allowing lower field currents with higher generator speeds.
d. shorter service with higher generator output.

37.04.04.07

66. What definitely affects regulator voltage control?

a. ambient temperature.
b. the amount of current put out by a DC generator or alternator.
c. the number of amps in a voltage regulator.
d. the change the battery has.

67. A fully transistorized regulator:

a. has no moving parts.
b. doesn't have as long a life span as a regular regulator.
c. has no capacitor.
d. has no diodes.

68. The alternator regulator differs from the DC generator regulator in what way?

a. the alternator regulator only has a current regulator.
b. the DC generator has only a current regulator.
c. the alternator regulator only has a voltage regulator.
d. the DC generator has two circuits.

37.04.04.07 (continued)

69. To clean the points on a voltage regulator, either hard or soft, you use:

a. 400 silicon carbide paper.
b. suitable material for hardness of points.
c. a special point file.
d. a fine hard carbon file.

70. Before making each test on the voltage regulator, you must:

a. disconnect it.
b. normalize it.
c. polarize it.
d. take off the cover.

37.04.04.08

71. Excessive resistance in the regulator wiring circuit will cause:

a. fluctuation in the ammeter.
b. an over output in electricity.
c. fluctuation in the voltmeter.
d. a steady voltmeter reading.

72. It is important to disconnect the ground cable at battery when removing test equipment:

a. so you won't overcharge your battery.
b. so you won't get a shock.
c. because you may short out the field circuit.
d. so your battery can recharge itself.

73. In a charging circuit resistance test, the voltmeter (with 10 amps flowing through a circuit) should not exceed:

a. .3 volts.
b. .4 volts.
c. .5 volts.
d. .6 volts.

74. In a voltage regulator test the instrument(s) you use is (are):

a. a hydrometer.
b. a voltmeter and hydrometer.
c. an ammeter and hydrometer.
d. an ammeter and voltmeter.

75. You would measure temperature of regulator by holding a thermometer:

a. 1/4 inch from regulator cover.
b. on the radiator to tell how hot it is.
c. on top of the regulator cover.
d. on the inside cover of the regulator.

37.04.05.01

76. The ends of an armature loop are fastened:

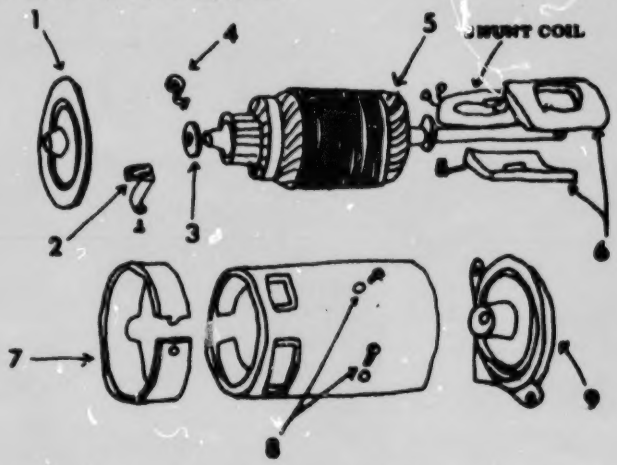
a. to copper brushes.
b. directly to the ends of another armature loop.
c. directly to the brush end-plate.
d. to commutator segments.

77. When the starter motor armature begins to turn, the starter gear:

a. releases from the flywheel.
b. moves out and engages the ring gear.
c. moves out of its magnetic field into another field.
d. remains in a neutral position.

78. In the diagram,* what is number 8?

a. mounting screws.
b. pole shoe screws.
c. terminal screws.
d. brush screws.



79. In order to provide a means for the starting motor to turn the flywheel, a large ring gear is either welded to the flywheel or:

a. center punched to hold gear on to flywheel.
b. screwed into the flywheel.
c. soldered onto the flywheel.
d. heated and shrunk onto the flywheel.

80. The solenoid has what function?

a. draws current from the starter and returns it to the battery.
b. increases power or torque of the starter.
c. is a safety precaution so you won't burn up the starter.
d. directs battery current to the starter.

37.04.05.02

81. The General Motors solenoid switch on a cranking motor closes the circuit between battery and cranking motor:

a. and has only one winding going to the armature.
b. and also reduces the amount of electricity going to the armature.
c. and doesn't produce a magnetic field.
d. and also shifts the drive pinion into mesh with the ring gear.

*(Adapted from Auto Mechanic Fundamentals, Stockel, Goodheart-Wilcox, 1974, p. 393, Figure 16-76.)

37.04.05.02 (continued)

82. In a typical solenoid switch there are:

a. three windings.
b. five windings.
c. two windings.
d. four windings.

83. The winding(s) in a solenoid switch:

a. doesn't produce a magnetic field.
b. regulate the flow of electricity from the generator.
c. produce a magnetic field.
d. acts as a ground.

37.04.05.03

84. In a starter drive unit, a worn or chipped ring gear or stator pinion is:

a. the usual cause for noisy operations.
b. the cause of most trouble in a starter.
c. something that never happens in a starter.
d. very hard to find when it goes bad.

85. A Ford auto-lite starter with integral positive engagement drive has:

a. to be torn down completely in order to repair it.
b. a positive engagement drive built into the starter.
c. a solenoid which activates the starter drive.
d. brushes which are stationary in their holders.

37.04.05.04

86. During a free speed test on a Delco starter, a tachometer:

a. tells you how fast your brushes have to work to produce electricity.
b. will let you know how fast your engine is going.
c. measures armature revolutions per minute.
d. has no function in this test.

87. On a Delco-Remy starter, some solenoids have a terminal identified with the letter (R) which is:

a. designed to put less electricity to the armature.
b. not important if you don't have a six volt system.
c. connected to the battery side of the ignition coil.
d. a way of returning extra electricity to battery.

88. On a Delco-Remy starter with enclosed shift lever, the solenoid is attached:

a. on the drive end housing.
b. on the armature.
c. on the over-running clutch.
d. by a dust baud.

37.04.05.04 (continued)

89. The Delco-Remy starter with enclosed shift lever has an overrunning clutch:

a. which keeps the pinion gear engaged with flywheel.
b. and is the only starter which has one.
c. which is operated by a solenoid.
d. which is exposed to weather elements.

90. The commutator may be cleaned by:

a. emery cloth.
b. washing it with a light solvent.
c. a wire brush.
d. 00 sandpaper.

37.04.05.05

91. Wher you are diagnosing a starter problem with the headlights burning and they go out as the starter switch is closed, it would indicate:

a. the solenoid is grounding out.
b. the battery may be run down.
c. a poor connection between battery and starter.
d. the wiring is reversed on the regulator.

92. To determine the cause of abnormal operation in the starter motor:

a. you should test it with a hydrometer.
b. you should alternate the current going to the starter.
c. you should test for specific gravity.
d. it should be submitted to a no-load and torque test.

93. If the lights dim considerably as the starter switch is closed and the starter operates slowly, you problem is:

a. that you have an open circuit in your solenoid.
b. too long cables causing a high voltage drop to your starter.
c. probably that of too much heat on your starter armature.
d. a low battery or some mechanical condition in engine or starter.

94. On a Chrysler direct drive starter, you install a thrust washer on commutator end of armature shaft:

a. to obtain no end play in commutator.
b. to obtain .010 minimum end play.
c. for a spacer.
d. to obtain a good contact with commutator.

95. When reassembling a starter, you should lubricate armature shaft and splines:

a. with S.A.E. 10w40.
b. with a light grease.
c. with graphite.
d. with either a or b above.

37.04.06.01

96. The primary circuit starts at the battery and then flows to the:

a. voltage regulator.
b. ignition switch.
c. resistor.
d. coil.

97. The source of electrical energy needed to operate the ignition system is:

a. the generator or alternator.
b. the coil.
c. the voltage regulator.
d. the battery.

98. The resistor in an ignition system control the amount of current reaching the:

a. coil.
b. voltage regulator.
c. alternator or generator.
d. battery.

99. The advantage of dual points over single points is that:

a. at high speeds they can give a more adequate spark.
b. it increases the open time to which the circuit is exposed.
c. you can be off on setting of points and car will still be in tune.
d. there is none.

100. A relay in an ignition system is an electromagnetic device used for:

a. building up current.
b. breaking the circuit to reduce distance of electrical flow.
c. changing the path of electricity so wires do not burn up.
d. delaying current so electricity can travel around the coil.

37.04.06.02

101. In the diagram on the following page, identify item #2:

a. distributor wire.
b. secondary wiring circuit.
c. condenser relay.
d. resistor bypass.

102. In the same diagram, identify item #7:

a. condenser.
b. ballast resistor.
c. distributor.
d. breaker points.

37.04.06.02 (continued)

103. In the diagram below, identify item #3.

a. ignition coil.
b. ballast resistor.
c. condenser.
d. breaker points.

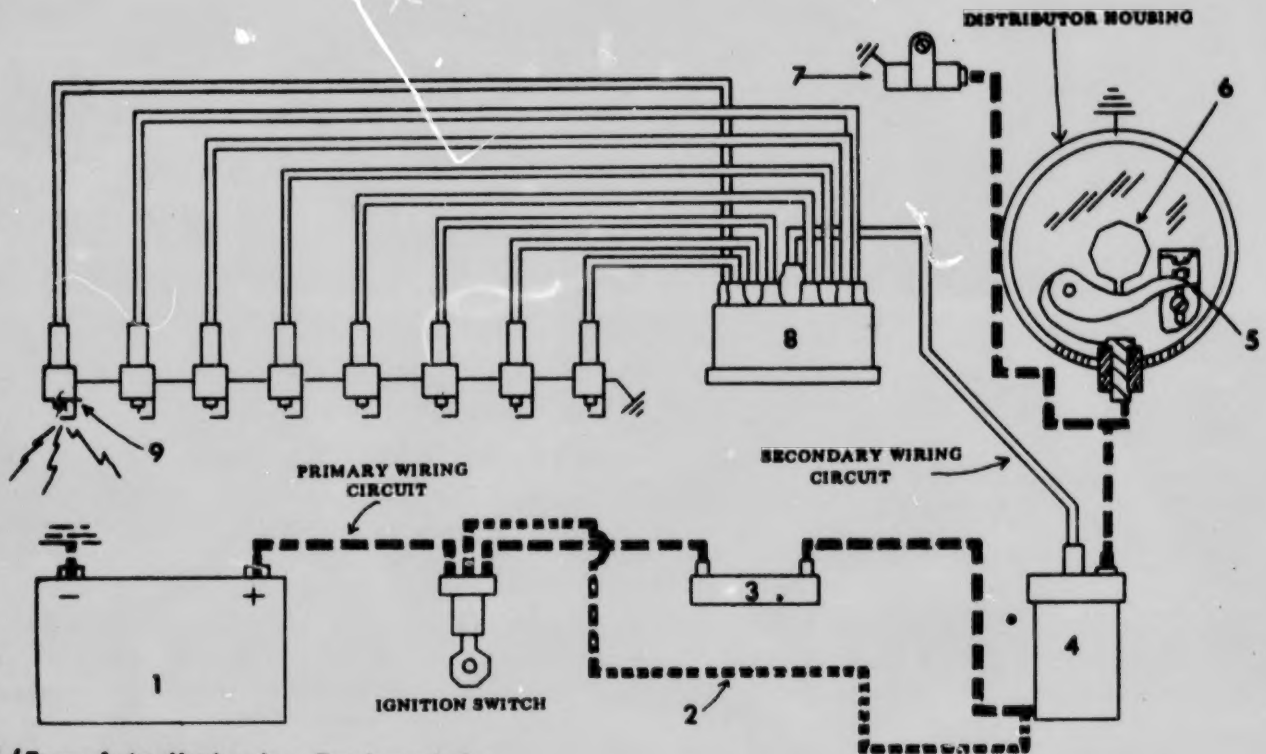
104. In the diagram below, identify item #9:

a. plug wires.
b. coil wires.
c. condenser.
d. spark plugs.

105. In the same diagram below, identify item #1:

a. frame.
b. battery.
c. voltage regulator.
d. distributor.

AUTOMOBILE IGNITION SYSTEM *



* (From Auto Mechanics Fundamentals, Stockel, Goodheart-Willcox, 1974, p. 52, Fig. 3-1.)

COURSE PRETEST ANSWER KEY: ELECTRICAL SYSTEMS

Occupational Area: _____
File Code: 37.04.00.00.B1-2
Name: _____
Family Pay Number _____ Sex M F (Circle 1)

ANSWERS

.04.01.01	1. A	37.04.03.01	21. A	37.04.04.02	41. C
	2. A		22. D		42. C
	3. D		23. C		43. D
	4. A		24. C		44. B
	5. C		25. C		45. D
.04.02.01	6. C	37.04.03.02	26. A	37.04.04.03	46. B
	7. A		27. A		47. b
	8. B		28. D		48. A
	9. C	37.04.03.03	29. C		49. D
	10. D		30. D		50. B
.04.02.02	11. C	37.04.03.04	31. C	37.04.04.04	51. C
	12. A		32. C		52. D
	13. D		33. D		53. C
	14. A	37.04.03.05	34. A		54. C
	15. B		35. A		55. B
04.02.03	16. A	37.04.04.01	36. A	37.04.04.05	56. D
	17. D		37. A		57. C
	18. B		38. A		58. C
	19. A		39. B		59. C
	20. C		40. B		60. D

COURSE PRETEST ANSWER KEY: ELECTRICAL SYSTEMS

Occupational Area: _____
File Code: 37.04.00.00.B1-2
Name: _____

ANSWERS

37.04.04.06

61. B _____
62. B _____
63. B _____
64. A _____
65. A _____

37.04.04.07

66. A _____
67. B _____
68. B _____
69. A _____
70. C _____

37.04.04.08

71. D _____
72. C _____
73. B _____
74. C _____
75. A _____

37.04.05.01

76. B _____
77. D _____
78. A _____
79. D _____
80. A _____

37.04.05.03

81. D _____
82. B _____
83. A _____
84. A _____
85. D _____

37.04.05.04

86. A _____
87. C _____
88. D _____
89. B _____
90. C _____

37.04.05.05

91. A _____
92. D _____
93. B _____
94. B _____
95. C _____

37.04.06.01

96. B _____
97. A _____
98. B _____
99. A _____
100. C _____

37.04.06.02

101. A _____
102. B _____
103. C _____
104. D _____
105. D _____
106. _____
107. _____
108. _____
109. _____
110. _____
111. _____
112. _____
113. _____
114. _____
115. _____
116. _____
117. _____
118. _____
119. _____
120. _____

COURSE POST TEST ANSWER KEY: ELECTRICAL SYSTEMS

Occupational Area: _____
File Code: 37.04.00.00.B1-2
Name: _____
Family Pay Number _____ Sex M F (Circle 1)

ANSWERS

7.04.01.01	1. A	37.04.03.01	21. A	37.04.04.02	41. C
	2. A		22. D		42. C
	3. D		23. C		43. D
	4. A		24. C		44. B
	5. C		25. C		45. D
.04.02.01	6. C	37.04.03.02	26. A	37.04.04.03	46. B
	7. A		27. A		47. B
	8. B		28. D		48. A
	9. C	37.04.03.03	29. C		49. D
	10. D		30. D		50. B
.04.02.02	11. C	37.04.03.04	31. C	37.04.04.04	51. C
	12. A		32. C		52. D
	13. D		33. D		53. C
	14. A	37.04.03.05	34. A		54. C
	15. B		35. A		55. B
04.02.03	16. A	37.04.04.01	36. A	37.04.04.05	56. D
	17. D		37. A		57. C
	18. B		38. A		58. C
	19. A		39. B		59. C
	20. C		40. B		60. D

UNIT TEST ANSWER SHEET

Occupational Ares: Automotive
File Code: 37.04
Name:
Family Pay Number: Sex: M F (Circle 1)

ANSWERS

0101	1.	A	0301	21.	A	0401	41.	D
	2.	A		22.	A		42.	C
	3.	D		23.	B		43.	D
	4.	C		24.	C		44.	D
	5.	A		25.	C		45.	D
0201	6.	D	0302	26.	A	0403	46.	A
	7.	D		27.	A		47.	D
	8.	C		28.	A		48.	C
	9.	C	0303	29.	D		49.	A
	10.	B		30.	C		50.	A
0202	11.	B	0304	31.	D	0404	51.	A
	12.	D		32.	D		52.	C
	13.	A		33.	D		53.	C
	14.	A	0305	34.	C		54.	B
	15.	A		35.	A		55.	C
0203	16.	C	0401	36.	B	0405	56.	B
	17.	A		37.	C		57.	C
	18.	D		38.	D		58.	C
	19.	C		39.	A		59.	C
	20.	B		40.	A		60.	B

UNIT TEST ANSWER SHEET

Occupational Area: Automotive
File Code: 37.04
Name:

ANSWERS

0406	61.	A	0502	81.	D	0602	101.
	62.	D		82.	C		102. A
	63.	A		83.	C		103. B
	64.	A	0503	84.	A		104. D
	65.	A		85.	B		105.
0407	66.	A	0504	86.	C		106.
	67.	A		87.	C		107.
	68.	C		88.	A		108.
	69.	B		89.	C		109.
	70.	B		90.	D		110.
0408	71.	A	0505	91.	C		111.
	72.	C		92.	D		112.
	73.	A		93.	D		113.
	74.	D		94.	B		114.
	75.	A		95.	D		115.
0501	76.	B	0601	96.	B		116.
	77.	B		97.	D		117.
	78.	B		98.	A		118.
	79.	D		99.	A		119.
	80.	D		100.	B		120.

File Code: 37.04.01.00.B1-1

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Experience Guide

UNIT: FUNDAMENTALS OF ELECTRICAL SYSTEMS

RATIONALE:

The fundamentals in this unit will give you an introduction to the theory of electricity.

PREREQUSITES:

None

OBJECTIVE:

Recognize the elements and theory of operation of electricity.

RESOURCES:

Printed Material

Auto Mechanics Fundamentals, Martin W. Stockel, Goodheart-Willcox Company, Inc.

GENERAL INSTRUCTIONS:

This Unit consists of one Learning Activity Package (LAP). The LAP will provide specific information for completion of a learning activity.

The general procedure for this Unit is as follows:

(1) Read the assigned Learning Activity Package (LAP).
(2) Begin and complete the assigned LAP.
(3) In this Unit, the LAP and Unit test is combined. This combined test is taken after completing the last LAP in the Unit.
(4) Take the Unit/LAP test as described in the Unit LEG "Evaluation Procedures".
(5) Proceed to the next assigned unit.

PERFORMANCE ACTIVITY:

.01 Fundamentals of Electricity

EVALUATION PROCEDURE:

When pretesting:

1. Take the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of the pretest.

Principal Author(s): C. Schramm/W. Osland

When post testing:

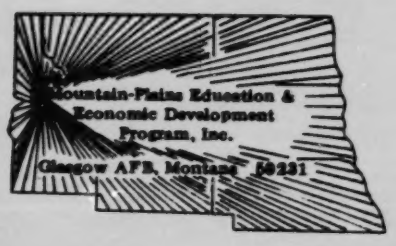
1. Take the multiple-choice unit post test.
2. There is no performance test for this unit.

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package (LAP) listed on your Student Progress Record (SPR).

Student: _____ File Code: 37.04.01.00.B1-2
37.04.01.01.B1-2

Date: _____ Date Published: 3/17/76



UNIT/LAP PRETEST: FUNDAMENTALS OF ELECTRICAL SYSTEMS

1. The Electron Theory is based on the assumption that electrical phenomenon is produced by:

   a. hydrogen and oxygen.
   b. anything that has weight and takes up space.
   c. the makeup of a molecule.
   d. a flow of electrons from one area to another.

2.

3. An atom is:

   a. what makes up matter and has a nucleus and electrons.
   b. the electrically charged particle which escaped from the electron.
   c. smallest that matter can be broken down to and retain all properties.
   d. made up completely of electrons.

4. The negative area of a flow of electricity can be determined by:

   a. the excess number of electrons in an area.
   b. what matter the electricity is made of.
   c. the way the magnetic field is turning, right or left.
   d. the shortage of electrons in an area.

5. The term "magnetic line of force" is used to describe:

   a. the reaction of charging a battery.
   b. why a light bulb will light up through a filament.
   c. the invisible magnetic force involved in a field.
   d. the continuity of a circuit.

6. The amount of electrons passing any given point in a circuit in one second determines:

   a. the attracting effect of a charged body.
   b. the pressure differential.
   c. the amount of current flowing.
   d. the resisting of protons.

7. In order to use a voltmeter correctly, it must be attached:

   a. in a parallel circuit.
   b. and grounded in two places so you won't destroy the voltmeter.
   c. in a series circuit.
   d. away from the battery so we don't get voltage from the battery.

8. You need only one wire to most electric devices in an automobile because:

   a. the auto body or frame acts as a 2nd wire to complete the connection.
   b. electricity is alternating back and forth through the wire.
   c. once electricity is carried to a device it is used up by the device.
   d. electrons flow different directions on the top and bottom of a wire.

9. If an atom has more protons than electrons, it is said to have:

   a. negative charge.
   b. a positive charge.
   c. a repelling effect on electrons.
   d. current flow.

10. In order to obtain a reading on an ammeter, it must be connected in:

   a. a series circuit.
   b. OHM circuit.
   c. a resistance circuit.
   d. a parallel circuit.

UNIT/LAP PRETEST ANSWER KEY: FUNDAMENTALS OF ELECTRICAL SYSTEMS

1. d
2. b
3. a
4. a
5. c
6. c
7. a
8. a
9. b
10. a

File Code: 37.06.01.01.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Fundamentals of Electricity

OBJECTIVE:

Recognize the elements and theory of operation of electricity.

EVALUATION PROCEDURE:

80% correct on Unit/LAP Post Test.

RESOURCES:

Auto Mechanics Fundamentals, Stockel.

PROCEDURE:

Steps

1. Obtain a text copy and secure a quiet place to study.
2. Read Chapter 19, "Electrical System Fundamentals", from page 365 up to "Battery" on page 372.
3. Study the figures 19-1 through to 19-22 closely.
4. Neatly answer on separate paper from page 405, Questions #1 through 23.
5. Upon completion, give answer sheet to the instructor for evaluation.
6. Return text to the proper shelf.
7. Take and score the Unit/LAP test.
8. Upon successful completion, proceed to the next unit.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.04.01.00 37.04.01.01

Date: _____ Date Published: 3-17-76

Revised: 8-25-78

Mountain-Plains Education & Economic Development Program, Inc. Glasgow AFB, Montana 59231

UNIT/LAP POST TEST: FUNDAMENTALS OF ELECTRICAL SYSTEMS (A)

1. The negative area of a flow of electricity can be determined by:

   a. the way the magnetic field is turning, right or left.
   b. what matter the electricity is made of.
   c. the shortage of electrons in an area.
   d. the excess number of electrons in an area.

2. An electron is:

   a. a particle found only in hydrogen atoms.
   b. the most advanced make-up of a positron.
   c. a negatively charged particle.
   d. a positively charged particle.

3. If an atom has more protons than electrons, it is said to have:

   a. a positive charge.
   b. a negative charge.
   c. a repelling effect on electrons.
   d. current flow.

4. The accepted theory regarding electricity is termed:

   a. Law of Energy.
   b. Electron Theory.
   c. OHM's Law.
   d. Newton's Law.

5. You need only one wire to most electric devices in an automobile because:

   a. once electricity is carried to a device, it is used up by the device.
   b. electrons flow different directions on the top and bottom of a wire.
   c. electricity is alternating back and forth through the wire.
   d. the auto body or frame acts as a second wire to complete the connection.

6. The amount of electrons passing any given point in a circuit in one second determines:

   a. the attracting effect of a charged body.
   b. the amount of current flowing.
   c. the pressure differential.
   d. the resisting of protons.

7. The diagram* represents:

   a. Law of Eminent Ions
   b. OHM's Law.
   c. energy in reserve.
   d. electricity is removed.

*(Adapted from Auto Mechanics Fundamentals, Stockel, Goodheart-Wilcox, 1969, page 317.)

8. In order to use a voltmeter correctly, it must be attached:

   a. in a parallel circuit.
   b. away from the battery so we don't get voltage from the battery.
   c. and grounded in two places so you won't destroy the voltmeter.
   d. in a series circuit.

9. Which of the following is not a form of OHM's law?

   a. $R = 1/E$
   b. $E = 1\ R$
   c. $R = \frac{E}{I}$
   d. $1 = \frac{E}{R}$

10. In order to obtain a reading on an ammeter, it must be connected in:

   a. a parallel circuit.
   b. an OHM circuit.
   c. a series circuit.
   d. a resistance circuit.

37.04.01.00
37.04.01.01

UNIT/LAP POST TEST ANSWER KEY: FUNDAMENTALS OF ELECTRICAL SYSTEMS (A)

1. D
2. C
3. A
4. B
5. D
6. B
7. B
8. A
9. A
10. C

37.04.01.00.C1-2 (B)
37.04.01.01.C1-2

Student: _____ File Code: _____

Date: _____ Date Published: 6/17/77

Revised: 11-08-78

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT/LAP POST TEST: FUNDAMENTALS OF ELECTRICAL SYSTEMS (B)

1. In order to obtain a reading on an ammeter, it must be connected in:

   a. a parallel circuit
   b. an OHM circuit
   c. a series circuit
   d. a resistance circuit

2. In order to use a voltmeter correctly, it must be attached:

   a. in a parallel circuit
   b. away from the battery so we don't get voltage from the battery
   c. and grounded in two places so you won't destroy the voltmeter
   d. in a series circuit

3. The diagram* represents:

   a. Law of Eminent Ions
   b. OHM's Law
   c. energy in reserve
   d. electricity is removed

* (Adapted from Auto Mechanics Fundamentals, Stockel, Goodheart-Wilcox, 1969, p. 317.)

4. The amount of electrons passing any given point in a circuit in one second determines:

   a. the attracting effect of a charged body
   b. the amount of current flowing
   c. the pressure differential
   d. the resisting of protons

5. You need only one wire to most electric devices in an automobile because:

   a. once electricity is carried to a device, it is used up by the device
   b. electrons flow different directions on the top and bottom of a wire
   c. electricity is alternating back and forth through the wire
   d. the auto body or frame acts as a 2nd wire to complete the connection

6. The accepted theory regarding electricity is termed:

   a. Law of Energy
   b. Electorn Theory
   c. OHM's Law
   d. Newton's Law

7. If an atom has more protons than electrons, it is said to have:

   a. a positive charge
   b. a negative charge
   c. a repelling effect on electrons
   d. current flow

8. An electron is:

   a. a particle found only in hydrogen atoms.
   b. the most advanced make-up of a positron.
   c. a negatively charged particle.
   d. a positively charged particle.

9. The negative area of a flow of electricity can be determined by:

   a. the way the magnetic field is turning, right or left.
   b. what matter the electricity is made of.
   c. the shortage of electrons in an area.
   d. the excess number of electrons in an area.

10. Which of the following is not a form of OHM's law?

    a. $R = 1/E$

    b. $E = 1\ R$

    c. $R = \frac{E}{I}$

    d. $1 = \frac{E}{R}$

37.04.01.00 C1-2
37.04.01.01 C1-2 (B)

UNIT/LAP POST TEST ANSWER KEY: FUNDAMENTALS OF ELECTRICAL SYSTEMS (B)

1. C
2. A
3. B
4. B
5. D
6. B
7. A
8. C
9. D
10. A

37.04.01.00.C1-2 (C)

Student: _____ File Code: 37.04.01.01.C1-2

Date: _____ Date Published: 6/17/77

Revised: 11-08-78

UNIT/LAP POST TEST: FUNDAMENTALS OF ELECTRICAL SYSTEMS (C)

1. The diagram* represents:

a. Law of Eminent Ions
b. OHM's Law
c. energy in reserve
d. electricity is removed

* (Adapted from Auto Mechanics Fundamentals, Stockel, Goodheart-Wilcox, 1974, p. 317.)

2. In order to obtain a reading on an ammeter, it must be connected in:

a. a paralled circuit
b. an OHM circuit
c. a series circuit
d. a resistance circuit

3. The amount of electrons passing any given point in a circuit in one second determines:

a. the attracting effect of a charged body
b. the amount of current flowing
c. the pressure differential
d. the resisting of protons

4. The negative area of a flow of electricity can be determined by:

a. the way the magnetic field is turning, right or left
b. what matter the electricity is made of
c. the shortage of electrons in an area
d. the excess number of electrons in an area

5. You need only one wire to most electric devices in an automobile because:

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6. If an atom has more protons than electrons, it is said to have:

a. a positive charge
b. a negative charge
c. a repelling effect on electrons
d. current flow

7. In order to use a voltmeter correctly, it must be attached:

   a. in a parallel circuit.
   b. away from the battery so we don't get voltage from the battery.
   c. and grounded in two places so you won't destroy the voltmeter.
   d. in a series circuit.

8. The accepted theory regarding electricity is termed:

   a. Law of Energy.
   b. Electron Theory.
   c. OHM's Law.
   d. Newton's Law.

9. An electron is:

   a. a particle found only in hydrogen atoms.
   b. the most advanced make-up of a positron.
   c. a negatively charged particle.
   d. a positively charged particle.

10. Which of the following is not a form of OHM's law?

    a. $R = 1/E$

    b. $E = 1\ R$

    c. $R = \frac{E}{I}$

    d. $1 = \frac{E}{R}$

37.04.01.00 C1-2
37.04.01.01 C1-2 (C)

UNIT/LAP POST TEST ANSWER KEY: FUNDAMENTALS OF ELECTRICAL SYSTEMS (C)

1. B
2. C
3. B
4. D
5. D
6. A
7. A
8. B
9. C
10. A

37.04.01.00
37.04.01.01

UNIT/LAP POST TEST ANSWER KEY: FUNDAMENTALS OF ELECTRICAL SYSTEMS (A)

1. D
2. C
3. A
4. B
5. D
6. B
7. B
8. A
9. A
10. C

File Code: 37.04.02.00.B2-1

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Experience Guide

UNIT: BATTERY SERVICING

RATIONALE:

The fundamentals and techniques in this unit will enable you to test and service automotive storage batteries.

PREREQUISITES:

None

OBJECTIVES:

Recognize the components and the operation of the storage battery.
Test and service automotive storage batteries.

RESOURCES:

Printed Materials

Auto Mechanics Fundamentals. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Auto Service and Repair. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Operator's Manual for Test Equipment.

Audio/Visuals

Super 8 Sound Films: DCA Educational Products, Inc.

Charge-Volts Test--FAA272.
Load Test--FAA262.

Equipment

Automobile with battery to be serviced
Baking soda and water
Battery cable puller
Battery charger
Battery connection cleaner
Battery testing equipment
Fender covers
AVT Systems Super 8 mm Instant Film Loop Player
Tools, Basic Hand: Chisel and Punch Set
5/32" Pin Punch
3/16" Solid

Gauge, feeler (.002" - .025")

Hammer, ball peen
Hammer, plastic tip
Handle, speed
Hex Key Set

Principal Author(s): C. Schramm/W. Osland

Pliers, diagonal cutting
Pliers, needle nose

Scraper, gasket
Screwdriver, standard (Set)
Screwdriver, phillips (Set)
Screw starter

Socket Set (3/8" drive)
  extension (3")
  ratchet

Socket Set (1/4" drive)
  extension (3")
  handle (6" flex)
  ratchet

Socket, spark plug
  extension (6")

Wrench, combination (Set)
Wrench, combination ignition (Set)

GENERAL INSTRUCTIONS:

This Unit consists of three Learning Activity Packages (LAPs). Each LAP will provide specific information for completion of a learning activity.

The general procedure for this Unit is as follows:

(1) Read the first assigned Learning Activity Package (LAP).
(2) Begin and complete the first assigned LAP.
(3) Take and score the LAP test.
(4) Turn in the LAP test answer sheet.
(5) Determine the reason for any missed items on the LAP test.
(6) Proceed to and complete the next assigned LAP in the unit.
(7) Complete all required LAPs for the unit by following steps 3 through 6.
(8) Take the unit tests as described in the Unit LEG "Evaluation Procedures".
(9) Proceed to the next assigned unit.

PERFORMANCE ACTIVITIES:

.01 Fundamentals of the Storage Battery
.02 Servicing the Storage Battery
.03 Testing the Storage Battery

EVALUATION PROCEDURE:

When pretesting:

1. The student takes the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of the pretest.
3. The student then takes a unit performance test if the unit pretest was successfully completed.
4. Satisfactory completion of the performance test is meeting the criteria listed on the performance test.

When post testing:

1. The student takes a multiple-choice unit post test and a unit performance test.
2. Successful unit completion is meeting the listed criteria for the performance test.

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package (LAP) listed on your Student Progress Record (SPR).

Student: _____ File Code: 37.04.02.00.B1-2

Date: _____ Date Published: 3/17/76

UNIT PRETEST: BATTERY SERVICING

37.04.02.01.

1. Do not expose a charging battery to an open flame or a spark, because it gives off:

   a. hydrogen and oxygen gas.
   b. carbon tetrachloride gas.
   c. carbon dioxide gas.
   d. argon gas.

2. Battery acid will burn skin, clothes, and even steel; therefore, if you spill some, it is best to wash the area with:

   a. soap.
   b. coke.
   c. sulfuric acid.
   d. baking soda.

3. If battery acid is accidentally splashed on clothing or skin, one should flush the affected area with:

   a. water only.
   b. sulfuric acid.
   c. soap and water only.
   d. large amounts of water and then a mixture of baking soda and water.

4. An automobile battery is constructed of:

   a. 4 or 7 elements.
   b. 1 or 4 elements.
   c. 3 or 6 elements.
   d. 2 or 5 elements.

5. The main purpose of an automobile battery is to provide current for:

   a. the ignition system and starter motor until the car is running.
   b. headlights and taillights.
   c. the generator.
   d. turn signals.

37.04.02.02.

6. Battery hold-downs should be:

   a. as tight as possible.
   b. tight on one end, loose on the other.
   c. left slightly loose.
   d. firmly snug.

37.04.02.02. cont.

7.

8. When checking specific gravity, you should:

   a. draw enough fluid so the float touches the top of the float barrel.
   b. never add water before checking it.
   c. know how much G-force you have on your current load.
   d. clean the terminals on the battery.

9. Electrolyte temperature for fast charging must not exceed:

   a. 160 degrees F.
   b. 125 degrees F.
   c. 100 degrees F.
   d. 212 degrees F.

10. It is best to remove cables from the battery with:

   a. anything that is available.
   b. a terminal puller.
   c. a screwdriver so you can split the cable.
   d. a slip joint pliers for maneuverability.

37.04.02.03.

11. You should never attempt the capacity test if:

   a. you have a fully charged battery.
   b. the specific gravity is below 1·220·
   c. the battery is in the car.
   d. the battery is less than one year old.

12. Before removing and testing a battery, you should:

   a. check the electrolyte.
   b. see if the battery has any charge.
   c. wash it off with water only.
   d. clean battery with baking soda and water.

13. Electrolyte temperature for slow charging must not exceed:

   a. 125 degrees.
   b. 85 degrees.
   c. 212 degrees.
   d. 100 degrees.

37.04.02.03. cont.

14. A specific gravity test measures the electrolyte in a battery and:

a. tells you how much G-force you have.
b. tells you how warm or how cold your battery is.
c. tells you how old it is.
d. determines the approximate state of charge.

15. A hydrometer tests or checks:

a. how old your battery is.
b. battery corrosion.
c. specific gravity.
d. the water level in the cell batteries.

UNIT PRETEST ANSWER KEY: BATTERY SERVICING

LAP .01

1. a
2. d
3. d
4. c
5. a

LAP .02

6. d
7. a
8. b
9. b
10. b

LAP .03

11. b
12. d
13. a
14. d
15. c

File Code: 37.04.02.01.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Fundamentals of the Storage Battery

OBJECTIVE:

Identify in writing the components and correct operation of the storage battery.

EVALUATION PROCEDURE:

Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Auto Mechanics Fundamentals, Stockel.

Filmstrips:
Charge-Volts Test--FAA272.
Load Test--FAA262.

PROCEDURE:
1. Obtain a text copy and secure a quiet place to study.
2. From chapter 19, read "Battery", page 372 to "Generator" on page 376.
3. Study figures 19-23 through 19-34. Notice especially the battery efficiency chart, figure 19-31.
4. Neatly answer on separate paper the questions on page 405, Questions #24 through 36.
5. Upon completion, give answer sheet to the instructor for evaluation.
6. Return text to the proper shelf.
7. View filmstrips #FAA 262 Load Test
   #FAA 272 Charge-Volts Test
8. Return filmstrips.
9. Take and score the LAP test.
10. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.04.02.01

Date: _____ Date Published: 3-04-76

Revised: 8-25-78

LAP TEST: FUNDAMENTALS OF THE STORAGE BATTERY

1. Do not expose a charging battery to an open flame or a spark, because it gives off:

   a. carbon dioxide gas.
   b. argon gas.
   c. carbon tetrachloride gas.
   d. hydrogen and oxygen gas.

2. Electricity flows out of a battery from:

   a. negative to negative.
   b. positive to negative.
   c. negative to positive.
   d. positive to positive.

3. Battery acid will burn skin, clothes, and even steel; therefore, if you spill some, it is best to wash the area with:

   a. water and baking soda.
   b. coke.
   c. sulfuric acid.
   d. hard water.

4. When charging, a battery converts electricity into:

   a. chemical energy.
   b. raw energy.
   c. a positive charge.
   d. a negative charge.

5. A battery's specific gravity can be measured by using a(n):

   a. ohmmeter.
   b. hydrometer.
   c. ammeter.
   d. thermometer.

6. Surplus electrons flow out of a battery from:

   a. negative to negative.
   b. positive to positive.
   c. positive to negative.
   d. negative to positive.

7. If battery acid is accidentally splashed on clothing or skin, one should flush the affected area with:

   a. large amounts of water and then a mixture of baking soda and water.
   b. soap and water only.
   c. sulfuric acid.
   d. water only.

8. The main purpose of an automobile battery is to provide current for:

   a. turn signals.
   b. the radio and other accessories.
   c. headlights and taillights.
   d. the ignition system and starter motor until the car is running.

9. An automobile battery is constructed of:

   a. 4 or 7 elements.
   b. 2 or 5 elements.
   c. 1 or 4 elements.
   d. 3 or 6 elements.

10. The specific gravity of electrolyte should be between:

   a. 1.160-1.260
   b. 1.260-1.280
   c. 1.180-1.200
   d. 1.150-1.180

LAP TEST ANSWER KEY: FUNDAMENTALS OF THE STORAGE BATTERY

1. D
2. C
3. A
4. A
5. B
6. D
7. A
8. D
9. D
10. B

File Code: 37.04.02.02.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Servicing the Storage Battery

OBJECTIVE:

Service a storage battery.

EVALUATION PROCEDURE:

Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Automobile with battery needing service
Baking soda and water
Battery cable puller tool
Battery connection cleaner
Fender covers
Tools, Basic Hand (see Unit LEG)

Auto Service and Repair, Stockel.

PROCEDURE:

NOTE: Read pages 22-1 through 22-10 in Auto Service and Repair.

NOTE: To avoid shorts be sure to: a) Always disconnect the negative cable first during removal. b) Always connect the positive cable first during installation.

1. Place fender covers.
2. Apply baking soda and water mixture to remove the corrosion build-up on the battery. Flush with water.
3. Loosen battery cable clamps and remove. A cable puller tool may be needed to carefully remove the clamps without damaging the battery posts. Caution: Remove the negative cable first.
4. Remove the battery filter caps and inspect the electrolyte level. Fill to the proper level if necessary.
5. Using the battery connection cleaner, clean the battery posts and the cable clamps thoroughly.

Principal Author(s): J. Anderson/W. Osland

6. Re-install and tighten the positive cable first.
7. Re-install and tighten the negative cable.
8. Apply a light coating of battery connection protector to reduce future corrosion.
9. Ask the instructor to evaluate work.
10. Clean and return all equipment and tools.
11. Take and score the LAP test.
12. Upon satisfactory completion, proceed to the next LAP.

Battery Charger Operation Safety.

A. Check electrolyte level. Add water if needed.

B. Clean battery posts.

C. With charger in the "off" position connect the cable leads. Observe correct polarity.

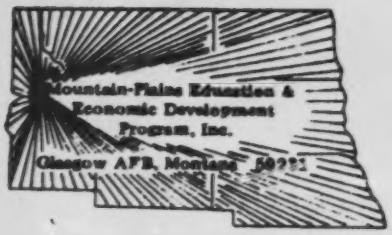
D. Turn the charger to low and observe meter. NOTE: It is better to slow charge a battery than to fast charge it in order to extend its normal life.

E. After full charge is obtained, de-activate the charger. Caution: One spark near the hydrogen gas of the battery will cause the battery to explode causing serious damage. Therefore, be sure the charger is fully "off" before disconnection.

Student: _____ File Code: 37.04.02.02

Date: _____ Date Published: 3-04-76

Revised: 8-25-78



LAP TEST: SERVICING THE STORAGE BATTERY

1. When checking specific gravity, you should:

   a. clean the terminals on the battery.
   b. never add water before checking it.
   c. know how much G-force you have on your current load.
   d. draw enough fluid so that the float touches the top of the float barrel.

2. When charging three or more batteries at once on one charger using a fast charge, you would:

   a. hook them up in a series circuit.
   b. take eight to ten times as long to charge them.
   c. not be able to do more than one at a time.
   d. hook them up in a parallel circuit.

3. Battery hold-downs should be:

   a. firmly snug.
   b. tight on one end, loose on the other.
   c. as tight as possible.
   d. left slightly loose.

4. You should be careful when charging a battery because it could:

   a. destroy the alternator or regulator if charged too long.
   b. cause corrosion if charged too much.
   c. transistorize the cells in the battery if charged too long.
   d. blow up if it is exposed to an open flame.

5. Before removing a battery from a car, you should:

   a. disconnect the alternator so you don't blow it up.
   b. drain the battery.
   c. hose down the battery with water only.
   d. apply baking soda and water mixture to remove the corrosion.

6. Which of the temperature corrected float readings below is correct for a reading of 1.125 at 110 degrees F.

   a. 1.105
   b. 1.137
   c. 1.115
   d. 1.100

7. A battery should be recharged when the hydrometer reads:

   a. more than 85%
   b. less than 75%
   c. less than 100%
   d. less than 85%

8. A specific gravity test measures the electrolyte in a battery and:

   a. what the battery temperature is.
   b. determines the approximate state of charge.
   c. how much carbon pile you have in your battery.
   d. how much G-force is on a current load.

9. It is important, when taking the battery out, to:

   a. disconnect the positive cable first.
   b. it doesn't matter which one you disconnect first.
   c. disconnect the starter cable first.
   d. disconnect the negative cable first.

10. The function of the voltmeter, in regard to a battery test, is:

   a. to check to see if positive lead is concurrent to negative lead.
   b. to check cell voltages.
   c. to check how much water is in a battery.
   d. to check for cracks in the battery casing.

LAP TEST ANSWER KEY: SERVICING THE STORAGE BATTERY

1. B
2. D
3. A
4. D
5. D
6. B
7. B
8. B
9. D
10. B

File Code: 37.04.02.03.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Testing the Storage Battery

OBJECTIVE:

Test a storage battery.

EVALUATION PROCEDURE:

Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Battery charger
Battery cleaners
Battery needing testing
Battery testing equipment
Fender covers
Tools, basic hand (see Unit LEG)

Auto Service and Repair, Stockel.
Operator's Manual for Test Equipment.

PROCEDURE:

NOTE: If difficulty occurs, review filmstrip #FAA262, Load Test and review pages 22-5 through 22-10 in Auto Service and Repair.

1. Place fender covers.
2. Clean battery with baking soda and water.
3. Loosen and remove battery cable clamps properly. Remember: negative cable first.
4. Check electrolyte level. Fill if necessary.
5. Attach battery load test equipment following the operator's manual.
6. Perform the recommended tests according to the operator's manual. Record results and compare to the manufacturers' specifications.

Principal Author(s): J. Anderson/W. Osland

7. If the battery's charge is too low for accurate testing, charge the battery with the battery charger.

8. When the battery charge is completed, perform the recommended tests.

9. Clean the battery connections and install the battery.

10. When completed, ask the instructor to evaluate work.

11. Clean and return all tools and equipment.

12. Take and score the LAP test.

13. Upon successful completion, obtain a copy of 37.05.02 Unit Post Test. Answer all of the questions and return the test to the instructor for evaluation.

14. Upon successful completion of Unit Post test, proceed to the next unit.

Student: _____ File Code: 37.04.02.03

Date: _____ Date Published: 3-04-76

Revised: 8-25-78

LAP TEST: TESTING THE STORAGE BATTERY

1. Slow charging passes what relatively small amount of current?

   a. 5-7 amps.
   b. 1 amp per hour only.
   c. 1-2 amps.
   d. 15-20 amps.

2. A voltmeter tests:

   a. how warm or how cold your battery is.
   b. how old your battery is.
   c. to check for casing cracks by putting pressure inside the battery.
   d. cell voltages.

3. If the battery is too low for testing, you should:

   a. do the tests that you can.
   b. charge the battery.
   c. disregard the battery.
   d. just check to see if there are any cracks in the casing.

4. Before removing and testing a battery you should:

   a. check the electrolyte.
   b. clean battery with baking soda and water.
   c. wash it off with water only.
   d. see if the battery has any charge.

5. A battery with a 25 point specific gravity difference between cells indicates that:

   a. the battery should be slow charged.
   b. the electrolyte is bad.
   c. the battery is starting to fail.
   d. the battery should be fast charged.

6. Fast charging sends a relatively heavy initial current of:

   a. 50-60 amps for 12 volt batteries.
   b. not over 25 amps for a 12 volt battery.
   c. 90-100 amps for 12 volt batteries.
   d. 10-20 amps for 12 volt batteries.

7. You should never attempt the capacity test:

   a. when you have a fully charged battery.
   b. the battery is in the car.
   c. the specific gravity is below 1.220
   d. if the battery is less than one year old.

8. A hydrometer tests or checks:

   a. specific gravity.
   b. how old your battery is.
   c. battery corrosion.
   d. the water level in the cell batteries.

9. When checking specific gravity, you should:

   a. never add water before checking it.
   b. never check it while it is in the car.
   c. add water so all of the cells are full.
   d. never check it when it is below 32 degrees F.

10. A specific gravity test measures the electrolyte in a battery and:

   a. tells you how much G-force you have.
   b. tells you how warm or how cold your battery is.
   c. determines the approximate state of charge.
   d. none of the above.

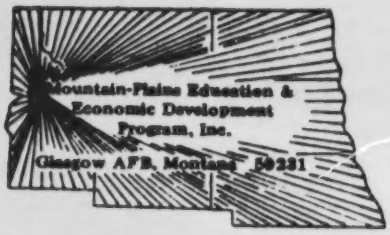
LAP TEST ANSWER KEY: TESTING THE STORAGE BATTERY

1. A
2. D
3. B
4. B
5. C
6. A
7. C
8. A
9. A
10. C

Student: _____ File Code: 37.04.02.00 (A)

Date: _____ Date Published: 3-17-76

Revised: 8-25-78



UNIT POST TEST: BATTERY SERVICING (A)

37.04.02.01

1. The specific gravity of a battery can be measured by a(n):

   a. ohmmeter.
   b. ammeter.
   c. hydrometer.
   d. thermometer.

2. Surplus electrons flow out of a battery from:

   a. negative to positive.
   b. negative to negative.
   c. positive to positive.
   d. postivie to negative.

3. The battery's main purpose is to:

   a. supply current for starter.
   b. supply electrical needs of lights.
   c. supply current for ignition.
   d. all of the above.

4. Electricity flows out of a battery from:

   a. negative to positive.
   b. negative to negative.
   c. positive to negative.
   d. positive to positive.

5. When charging, a battery converts electricity into:

   a. a positive charge.
   b. raw energy.
   c. chemical energy.
   d. a negative charge.

37.04.02.02

6. When activating a dry charged battery, why is it important to just cover the separators with electrolyte:

   a. to save electrolyte.
   b. the separators only need to be wet.
   c. to leave room for expansion when charging.
   d. it does not matter how full they are.

37.04.02.02 (continued)

7. A battery should be recharged when the hydrometer reads:

   a. more than 85%
   b. less than 75%
   c. less than 85%
   d. less than 100%

8. A specific gravity test measures the electrolyte in a battery and:

   a. how much carbon pile you have in your battery.
   b. determines the approximate state or charge.
   c. what the battery temperature is.
   d. how much G-force is on a current load.

9. It is important when taking the battery out to:

   a. disconnect the positive cable first.
   b. disconnect the starter cable first.
   c. disconnect the negative cable first.
   d. it doesn't matter which one you disconnect first.

10. When storing a wet battery, its charge will last longer if:

   a. it is stored in a warm place, 75 degrees or above.
   b. you store it in a cool, dry area.
   c. you put a trickle charger on it.
   d. it is a low charge to start with.

37.04.02.03

11. Slow charging passes a relatively small amount of current of:

   a. 5 - 7 amps.
   b. 15 -20 amps.
   c. 1 amp per hour only.
   d. 1 - 2 amps.

12. When checking specific gravity, you should:

   a. add water so all of the cells are full.
   b. never add water before checking it.
   c. never check it while it is in the car.
   d. never check it when it is below 32 degrees F.

13. If the battery is too low for testing, you should:

   a. charge the battery.
   b. disregard the battery.
   c. do the tests that you can.
   d. just check to see if there is any cracks in the casing.

37.04.02.03 (continued)

14. Fast charging sends a relatively heavy initial current of:

    a. 10-20 amps for 12 volt batteries.
    b. 90-100 amps for 12 volt batteries.
    c. 50-60 amps for 12 volt batteries.
    d. not over 25 amps for a 12 volt battery.

15. Mechanic "A" says when slow charging more than one battery you connect them in parallel.

    Mechanic "B" says when fast charging more than one battery you connect them in series.

    Who is right?

    a. Mechanic "A" only.
    b. Mechanic "B" only.
    c. Both "A" and "B".
    d. Neither "A" nor "B".

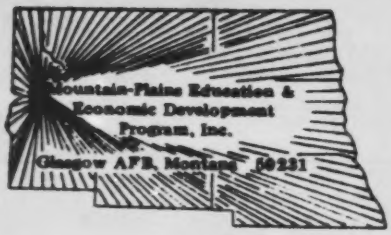
UNIT POST TEST ANSWER KEY: BATTERY SERVICING (A)

1. C
2. A
3. D
4. A
5. C
6. C
7. B
8. B
9. C
10. C
11. A
12. B
13. A
14. C
15. D

Student: _____ File Code: 37.04.02.00 (B)

Date: _____ Date Published: 3-17-76

Revised: 9-29-78



UNIT POST TEST: BATTERY SERVICING (B)

37.04.02.01

1. When charging, a battery converts electricity into:

   a. a positive charge.
   b. raw energy.
   c. chemical energy.
   d. a negative charge.

2. Electricity flows out of a battery from:

   a. negative to positive.
   b. negative to negative.
   c. positive to negative.
   d. positive to positive.

3. The battery's main purpose is to:

   a. supply current for starter.
   b. supply electrical needs of lights.
   c. supply current for ignition.
   d. all of the above.

4. Surplus electrons flow out of a battery from:

   a. negative to positive.
   b. negative to negative.
   c. positive to positive.
   d. positive to negative.

5. The specific gravity of a battery can be measured by a(n):

   a. ohmmeter.
   b. ammeter.
   c. hydrometer.
   d. thermometer.

37.04 02.02

6. When storing a wet battery, its charge will last longer if:

   a. it is stored in a warm place, 75 degrees or above.
   b. you store it in a cool, dry area.
   c. you put a trickle charger on it.
   d. it is a low charge to start with.

37.04.02.02 (continued)

7. It is important when taking the battery out to:

   a. disconnect the positive cable first.
   b. disconnect the starter cable first.
   c. disconnect the negative cable first.
   d. it doesn't matter which one you disconnect first.

8. A specific gravity test measures the electrolyte in a battery and:

   a. how much carbon pile you have in your battery.
   b. determines the approximate state or charge.
   c. what the battery temperature is.
   d. how much G-force is on a current load.

9. A battery should be recharged when the hydrometer reads:

   a. more than 85%
   b. less than 75%
   c. less than 85%
   d. less than 100%

10. When activating a dry charged battery, why it is important to just cover the separators with electrolyte:

   a. to save electrolyte.
   b. the separators only need to be wet.
   c. to leave room for expansion when charging.
   d. it does not matter how full they are.

37.04.02.03

11. Mechanic "A" says when slow charging more than one battery you connect them in parallel.

   Mechanic "B" says when fast charging more than one battery you connect them in series.

   Who is right?

   a. Mechanic "A" only.
   b. Mechanic "B" only.
   c. Both "A" and "B".
   d. Neither "A" nor "B".

12. Fast charging sends a relatively heavy initial current of:

   a. 10-20 amps for 12 volt batteries.
   b. 90-100 amps for 12 volt batteries.
   c. 50-60 amps for 12 volt batteries.
   d. not over 25 amps for a 12 volt battery.

37.04.02.03 (continued)

13. If the battery is too low for testing, you should:

    a. charge the battery.
    b. disregard the battery.
    c. do the tests that you can.
    d. just check to see if there is any cracks in the casing.

14. When checking specific gravity, you should:

    a. add water so all of the cells are full.
    b. never add water before checking it.
    c. never check it while it is in the car.
    d. never check it when it is below 32 degrees F.

15. Slow charging passes a relatively small amount of current of:

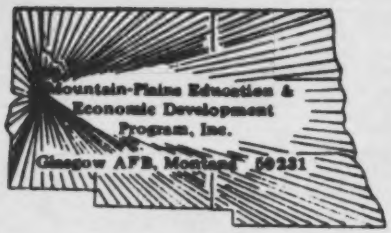
    a. 5 - 7 amps.
    b. 15 -20 amps.
    c. 1 amp per hour only.
    d. 1 - 2 amps.

UNIT POST TEST ANSWER KEY: BATTERY SERVICING (B)

1. C
2. A
3. D
4. A
5. C
6. C
7. C
8. B
9. B
10. C
11. D
12. C
13. A
14. B
15. A

Student: _____ File Code: 37.04.02.00 (C)

Date: _____ Date Published: 9-29-78



UNIT POST TEST: BATTERY SERVICING (C)

37.04.02.01

1. The battery's main purpose is to:

   a. supply current for starter.
   b. supply electrical needs of lights.
   c. supply current for ignition.
   d. all of the above.

2. The specific gravity of a battery can be measured by a(n):

   a. ohmmeter.
   b. ammeter.
   c. hydrometer.
   d. thermometer.

3. Electricity flows out of a battery from:

   a. negative to positive.
   b. negative to negative.
   c. positive to negative.
   d. positive to positive.

4. Surplus electrons flow out of a battery from:

   a. negative to positive.
   b. negative to negative.
   c. positive to positive.
   d. positive to negative.

5. When charging, a battery converts electricity into:

   a. a positive charge.
   b. raw energy.
   c. chemical energy.
   d. a negative charge.

37.04.02.02

6. When activating a dry charged battery, why is it important to just cover the separators with electrolyte:

   a. to save electrolyte.
   b. the separators only need to be wet.
   c. to leave room for expansion when charging.
   d. it does not matter how full they are.

37.04.02.02 (continued)

7. It is important when taking the battery out to:

   a. disconnect the positive cable first.
   b. disconnect the starter cable first.
   c. disconnect the negative cable first.
   d. it doesn't matter which one you disconnect first.

8. A battery should be recharged when the hydrometer reads:

   a. more than 85%
   b. less than 75%
   c. less than 85%
   d. less than 100%

9. When storing a wet battery, its charge will last longer if:

   a. it is stored in a warm place, 75 degrees or above.
   b. you store it in a cool, dry area.
   c. you put a trickle charger on it.
   d. it is a low charge to start with.

10. A specific gravity test measures the elecrolyte in a battery and:

   a. how much carbon pile you have in your battery.
   b. determines the approximate state or charge.
   c. what the battery temperature is.
   d. how much G-force is on a current load.

37.04.02.03

11. Slow charging passes a relatively small amount of current of:

   a. 5 - 7 amps.
   b. 15 -20 amps.
   c. 1 amp per hour only.
   d. 1 - 2 amps.

12. If the battery is too low for testing, you should:

   a. charge the battery.
   b. disregard the battery.
   c. do the tests that you can.
   d. just check to see if there is any cracks in the casing.

13. Mechanic "A" says when slow charging more than one battery you connect them in parallel.

   Mechanic "B" says when fast charging more than one battery you connect them in series.

   Who is right?

   a. Mechanic "A" only.
   b. Mechanic "B" only.
   c. Both "A" and "B".
   d. Neither "A" nor "B".

37.04.02.03 (continued)

14. Fast charging sends a relatively heavy initial current of:

    a. 10-20 amps for 12 volt batteries.
    b. 90-100 amps for 12 volt batteries.
    c. 50-60 amps for 12 volt batteries.
    d. not over 25 amps for a 12 volt battery.

15. When checking specific gravity, you should:

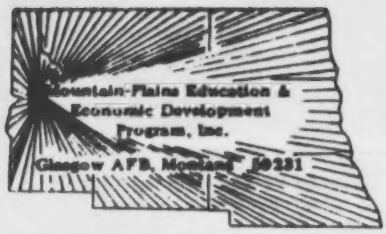
    a. add water so all of the cells are full.
    b. never add water before checking it.
    c. never check it while it is in the car.
    d. never check it when it is below 32 degrees F.

UNIT POST TEST ANSWER KEY: BATTERY SERVICING (C)

1. D
2. C
3. A
4. A
5. C
6. C
7. C
8. B
9. C
10. B
11. A
12. A
13. D
14. C
15. B

Student: _____ File Code: 37.04.02.00.B1-5

Date: _____ Date Published: 3/4/76



Family Pay Number: _____ Sex: M F (Circle 1)

UNIT PERFORMANCE TEST: BATTERY SERVICING

OBJECTIVE 1:

Services battery.

OBJECTIVE 2:

Tests battery.

TASK:

The student will be assigned a vehicle on which he must service and test the battery.

ASSIGNMENT:

CONDITIONS:

The student may use only those materials provided for the test and perform the test in the auto shop.

RESOURCES:

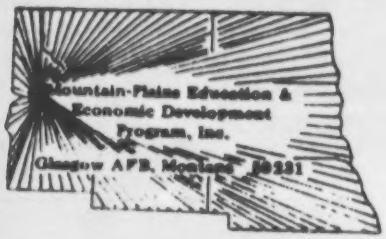
Fender Covers
Battery Water
Terminal Cleaner
Hydrometer
"Sun" Volt Amp Tester 28

RESOURCES: (Cont.)

Service Manuals
Time and Parts Manual
Baking Soda
Combination Ignition wrench set
Combination Wrench Set
Standard Screwdriver Set
Phillips Screwdriver Set
Feeler gauge - .002 through .025 inch
Hex Key Set
Diagonal Cutting Pliers
Needle Nose Plier
1/4" Drive Socket Set
Ratchet - 3" and 6" extensions - 6" flex handle
Ball Peen hammer
Plastic Tip Hammer
Screw Starter
Chisel and Punch Set
5/32" Pin Punch - 3/16" Solid
Gasket scraper
3/8" Drive Ratchet
3" Extension
Spark Plug Socket
6" Extension
Speed Handle
3/8" Drive Socket Set

Student: _____ File Code: 37.04.02.00.B1-5

Date: _____ Date Published: 3/4/76



Family Pay Number: _____ Sex: M F (Circle 1)

PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory_____ Unsatisfactory_____

	CRITERION Met	Not Met
Objective 1:		
1. Service battery.		
Criterion: Battery and terminals must be clean and		
battery cells must be full of water.		
Objective 2:		
2. Test specific gravity.		
Criterion: Cells must read above 1,200 and be uniform.		
3. Load test battery.		
Criterion: Voltage must remain above 9 volts on 12		
volt battery and 4.5 volts on a 6 volt		
battery.		
4. Complete test in allotted time.		
Criterion: Must meet flat rate on assigned vehicle.		
Student must satisfactorily complete 3 out of 4 line items		
to pass test.		

File Code: 37.04.03.00.B1-1

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Experience Guide

UNIT: LIGHTING SYSTEMS

RATIONALE:

The fundamentals and techniques in this Unit will enable you to diagnose and repair automotive lighting systems.

PREREQUISITES:

None

OBJECTIVES:

Recognize the components and the proper operation of the lighting system.
Use correct procedures for diagnoses and repairs of the lighting systems.

RESOURCES.

Printed Materials

Automotive Encyclopedia. Motor Services.
Motor's Auto Repair Manual. Motor, The Hearst Corporation. 1972 or equivalent.

Equipment

Automobile needing repair of: brake light and tail light
headlight and parking light
instrument light
turn signal

Circuit tester
Replacement parts as needed
Seat cover towel
Tools, Basic Hand: Chisel and Punch Set
5/32" Pin Punch
3/16" Solid

Gauge, feeler (.002" - .025")

Hammer, ball peen
Hammer, plastic tip
Handle, speed
Hex Key Set

Pliers, diagonal cutting
Pliers, needle nose

Principal Author(s): C. Schramm/W. Osland

Scraper, gasket
Screwdriver, standard (Set)
Screwdriver, phillips (Set)
Screw starter

Socket Set (3/8" drive)
extension (3")
ratchet

Socket Set (1/4" drive)
extension (3")
handle (6" flex)
ratchet

Socket, spark plug
extension (6")

Wrench, combination (Set)
Wrench, combination ignition (Set)

GENERAL INSTRUCTIONS:

This Unit consists of five Learning Activity Packages (LAPs). Each LAP will provide specific information for completion of a learning activity.

The general procedure for this Unit is as follows:

(1) Read the first assigned Learning Activity Package (LAP).
(2) Begin and complete the first assigned LAP.
(3) Take and score the LAP test.
(4) Turn in the LAP test answer sheet.
(5) Determine the reason for any missed items on the LAP test.
(6) Proceed to and complete the next assigned LAP in the unit.
(7) Complete all required LAPs for the unit by following steps 3 through 6.
(8) In this Unit, there are some LAPs that have tests combined with other LAP tests. These combined tests are taken after completing the last LAP covered by the test.
(9) Take the unit tests as described in the Unit LEG "Evaluation Procedures".
(10) Proceed to the next assigned unit.

PERFORMANCE ACTIVITIES:

.01 Fundamentals of the Lighting System
.02 Headlights and Parking Lights
.03 Tail Lights and Brake Lights
.04 Turn Signals
.05 Instrument Lights

EVALUATION PROCEDURE:

When pretesting:

1. The student takes the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of the pretest.
3. The student then takes a unit performance test if the unit pretest was successfully completed.
4. Satisfactory completion of the performance test is meeting the criteria listed on the performance test.

When post testing:

1. The student takes a multiple-choice unit post test and a unit performance test.
2. Successful unit completion is meeting the listed criteria for the performance test.

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package (LAP) listed on your Student Progress Record (SPR).

Student: _____ File Code: 37.04.03.00.B1-2

Date: _____ Date Published: 3/17/76

Mountain-Plains Education & Economic Development Program, Inc. Glasgow AFB, Montana 59231

UNIT PRETEST: LIGHTING SYSTEMS

37.04.03.01.

1. What is the approximate range of gap of the armature on an electric horn?

   a. .060 to .075 inch.
   b. .001 to .005 inch.
   c. .025 to .040 inch.
   d. .005 to .010 inch.

2. Voltage loss is also called:

   a. heat loss.
   b. decreased resistance.
   c. reducing arc.
   d. I R drop.

3. When aiming a sealed beam head lamp, what does the adjustment at the top of the retaining ring control?

   a. both to some degree.
   b. horizontal control of beam.
   c. neither one.
   d. vertical control of beam.

4. How is the light output of a sealed beam headlight affected by age?

   a. not seriously affected.
   b. improved with age.
   c. decreases rapidly.
   d. stays the same.

5. The horn relay is connected into the horn and the battery circuit in order to:

   a. burn out horn diaphragm by having too much current.
   b. bypass the variable resistance.
   c. make a more direct contact.
   d. raise the resistance.

37.04.03.02.

6. On a concealed headlamp system using vacuum, you would get vacuum from:

   a. a special vacuum pump.
   b. the intake manifold.
   c. the exhaust manifold.
   d. compression in the cylinder wall.

7. When making headlight adjustments, pushing on the center of both front and rear bumpers then rocking the car side to side is known as:

   a. testing the shocks.
   b. disturbing the center balance.
   c. leveling it.
   d. road feel.

8. The high beam terminal also feeds current to:

   a. the battery through the frame.
   b. the low beam lights.
   c. the high beam indicator lamp on the dash.
   d. the park lights.

9.

37.04.03.03.

10. When checking tail lights and you have none, you should check:

    a. relays.
    b. wires.
    c. bulbs.
    d. fuses.

11.

37.04.03.04.

12.

13. How many filaments are in a tail light?

    a. none.
    b. 2
    c. 3
    d. 1

37.04.03.05.

14. The instrument lights' wiring is:

    a. color coded for easy installation.
    b. connected directly to the battery terminal on the coil.
    c. hooked individually to instruments.
    d. not color coded.

15. If only one part of an instrument panel does not light up, it could indicate a:

    a. bad rheostat control.
    b. bad bulb.
    c. bad fuse.
    d. inaccurate gage.

UNIT PRETEST ANSWER KEY: LIGHTING SYSTEMS

LAP .01

1. c
2. d
3. d
4. a
5. c

LAP .02

6. b
7. c
8. c
9. a

LAP .03

10. d
11. a

LAP .04

12. b
13. b

LAP .05

14. a
15. b

File Code: 37.04.03.01.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Fundamentals of the Lighting System

OBJECTIVE:

Identify the components and proper operation of the lighting system.

EVALUATION PROCEDURE:

Score 80% on LAP study questions.
Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Automotive Encyclopedia, Motor Services.

PROCEDURE:

Steps

1. Obtain a text copy and secure a quiet place to study.
2. Read the chapter on "Lights, Lighting Circuits, Horns", pages 427-437.
3. Study figures 36-1 through to 36-26.
4. Neatly answer questions 1 through 26 from page 437 on separate paper. paper.
5. Give answer sheet to the instructor for evaluation.
6. Return text to shelf.
7. Take and score the LAP test.
8. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.04.03.01

Date: _____ Date Published: 6-16-76

Revised: 9-06-78

LAP TEST: FUNDAMENTALS OF THE LIGHTING SYSTEM

1. What is the permissible voltage drop between the battery and a lamp?

   a. 12 volts.
   b. 0.1 volts.
   c. 1·0 volts.
   d. 0·6 volts.

2. What two light circuits use the same bulb filament:

   a. directional and indicator lights.
   b. park and brake lights.
   c. brake and warning lights.
   d. directional and brake lights.

3. In the electrical area what does (open) mean:

   a. low resistance.
   b. high resistance.
   c. no connection.
   d. short to ground.

4. How is the light output of a sealed beam headlight affected by age?

   a. stays the same.
   b. improves with age.
   c. not seriously affected.
   d. decreases rapidly.

5. What causes the diaphragm on a modern horn to vibrate?

   a. horn relay.
   b. circuit breaker in the horn.
   c. air electromagnet.
   d. air circulating in the lines.

6. The horn relay is connected into the horn and the battery circuit in order to:

   a. raise the resistance.
   b. reduce the voltage drop in the horn circuit.
   c. burn out horn diaphragm by having too much current.
   d. bypass the variable resistance.

7. When aiming a sealed beam head lamp, what does the adjustment at the top of the retaining ring control?

   a. neither one.
   b. vertical control of beam.
   c. both to some degree.
   d. horizontal control of beam.

8. What kind of solder would you use to solder a 16 ga. wire to an 18 ga. wire:

   a. acid core.
   b. solid core.
   c. rosin core.
   d. 20-80 solid core.

9. The word candlepower refers to what:

   a. length of time a bulb will burn.
   b. the ability of a wire to give off light.
   c. the size of a bulb.
   d. the measurement of light intensity.

10. What is the unit of measure for the flow of electrons or current in a circuit?

   a. potential.
   b. amps.
   c. volts.
   d. load.

LAP TEST ANSWER KEY: FUNDAMENTALS OF THE LIGHTING SYSTEM

1. D
2. D
3. C
4. C
5. C
6. B
7. B
8. C
9. D
10. B

File Code: 37.04.03.02.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Headlights and Parking Lights

OBJECTIVE:

Diagnose and repair headlights and parking lights.

EVALUATION PROCEDURE:

Eight correct responses on a ten-item multiple-choice objective test to be taken after LAP 37.04.03.03.

RESOURCES:

Automotive Encyclopedia, Motor Services.
Motor's Auto Repair Manual.

Automobile needing headlight and parking light repair
Circuit tester
Replacement parts as needed
Tools, Basic Hand: (see Unit LEG)

PROCEDURE:

NOTE: Review pages 427-431 in Automotive Encyclopedia.

1. Activate parking lights and inspect all parking lights. Report on work order the defective lights.
2. If all lights fail to operate, check fuse panel for defective parking light fuse.
3. With circuit tester, test fuse contacts for current availability. Replace fuse if defective.
4. Remove lens from defective light unit. Remove bulb and examine bulb element.
5. Use circuit tester to test for current availability at bulb socket terminals. Replace bulb if defective.
6. If no current is available at socket contacts, trace wire back to the switch for open, or shorted circuits.

Principal Author(s): J. Anderson/W. Osland

File Code: 37.04.03.03.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Tail Lights and Brake Lights

OBJECTIVE:

Diagnose and repair tail lights and brake lights.

EVALUATION PROCEDURE:

Eight out of ten correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Automobile needing tail light or brake light repair
Circuit tester
Replacement parts as needed
Tools, Basic Hand: (see Unit LEG)

PROCEDURE:

Steps

1. Operate light switch and inspect tail lights for full operation.
2. If no lights operate, check fuse. Check current availability at the fuse contacts with the circuit tester. Replace fuse if defective.
3. Remove trim and lens of defective light unit. Remove and inspect bulb. Check current availability with circuit-tester. Replace bulb if defective.
4. If no current is available, trace wiring back to switch in search of shorts or open circuits.
5. When completed, operate and inspect tail lights for full operation.
6. With light switch off, depress and lock brake pedal in the activated position.

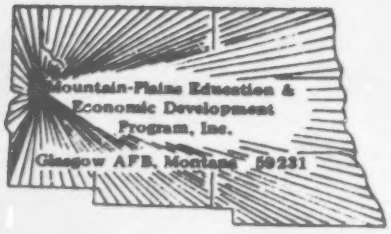
Principal Author(s): J. Anderson/W. Osland

7. Examine rear brake lights. If no lights at all, inspect fuse panel.
8. If one unit fails to operate, remove trim and lens and examine bulb. Test current availability with circuit tester. Replace bulb if defective.
9. Replace trim and lens when problem is solved.
10. Ask the instructor to evaluate the completed work.
11. Clean and return all tools and equipment.
12. Clean work area.
13. Take and score the LAP test.

Student: _____ File Code: 37.04.03.02 & 37.04.03.03

Date: _____ Date Published: 3-5-76

Revised: 9-6-78



LAP TEST: HEADLIGHTS AND PARKING LIGHTS/TAIL LIGHTS AND BRAKE LIGHTS

37.04.03.02

1. When making headlight adjustments, pushing on the center of both front and rear bumpers then rocking the car side to side is known as:

   a. testing the shocks.
   b. road feel.
   c. disturbing the center balance.
   d. leveling it.

2. All headlight adjustments should be made with:

   a. a full tank of gas, driver and passenger in car.
   b. mechanical aimers.
   c. the car running.
   d. no one in car, but have it sitting level.

3. When adjusting your headlights, your car must be how far from the test wall?

   a. 6 feet.
   b. 25 feet.
   c. 50 feet.
   d. 30 feet.

4. When adjusting #2 beam, your lights are adjusted:

   a. directly under the high beam.
   b. lower and to the left of the high beam.
   c. lower and to the right of the high beam.
   d. lower and each light is pointing outward on right and left side.

5. When adjusting #1 headlights on a four bulb car (using a wall chart), you must:

   a. have car running.
   b. be in a dark room, so lights show up on wall.
   c. align your front end.
   d. cover #2 headlights.

6. On a concealed head lamp system using vacuum, you would get vacuum from:

   a. the intake manifold
   b. the exhaust manifold.
   c. compression in the cylinder wall.
   d. a special vacuum pump.

7. The rear turn signal generally uses:

   a. the rail lamp filament.
   b. the stop lamp filament.
   c. its own filament.
   d. the parking lamp filament.

8. If one of the front turn signals should lose its ground:

   a. both lamps will burn out.
   b. neither lamp will light.
   c. the lamp with no ground will glow dimly.
   d. both lamps will glow dimly.

9. If the current through the turnsignal flasher is low the flasher will:

   a. burn out.
   b. stay on.
   c. stay off.
   d. flash very rapidly.

10. If only one unit fails on the brake lights, it would indicate:

   a. the bulb is bad.
   b. the park light is bad because it works in a series circuit.
   c. the fuse is burned out.
   d. there is no current to both tail lights.

LAP TEST ANSWER KEY: HEADLIGHTS AND PARKING LIGHTS/
TAIL LIGHTS AND BRAKE LIGHTS

1. D
2. D
3. B
4. C
5. D
6. A
7. B
8. D
9. B
10. A

File Code: 37.04.03.04.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Turn Signals

OBJECTIVE:

Diagnose and repair defective turn signals.

EVALUATION PROCEDURE:

Eight correct responses to a ten-item multiple-choice objective test to be taken after LAP #37.05.06.03.

RESOURCES:

Automobile needing turn signal repair
Circuit tester
Replacement parts as needed
Tools, Basic Hand: (see Unit LEG)

Automotive Encyclopedia, Motor Services.

PROCEDURE:

NOTE: Review page 432 in Automotive Encyclopedia.

1. With ignition on, activate turn signal switch to locate the defective lights.
2. If there is total loss of turn-signal lights, check fuse and fuse contacts for current availability with circuit tester. Replace fuse if defective.
3. If only one unit fails to operate, remove lens and inspect the bulb. Check for current availability with circuit tester.
4. If no current exists, trace wiring for shorts or open circuits.
5. Replace bulb if defective.
6. Replace lens.
7. Activate turn-signal switch to check turn-signal for full operation.
8. Ask the instructor to inspect your completed work.
9. Clean and return all tools and equipment.
10. Clean work area.
11. Proceed to next LAP. The LAP test will be taken after completion of LAP 37.05.06.03.

Principal Author(s): J. Anderson/W. Osland

File Code: 37.04.03.08.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Instrument Lights

OBJECTIVE:

Diagnose and repair defective instrument lighting system.

EVALUATION PROCEDURE:

Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Automobile needing instrument light repair
Circuit tester
Replacement parts as needed
Seat cover towel
Tools, Basic Hand: (see Unit LEG)

PROCEDURE:

Steps

1. Place seat-cover towel over the dash and your head to block out any exterior shop light.
2. Activate light switch and inspect all the instrument panels and shift indicator, for full operational lights.
3. If no lights are operational, turn the light switch to the left and to the right to operate the light rheostat control.
4. If still no lights, inspect the fuse panel for a defective fuse. Check current availability at contacts with circuit tester. Replace fuse if defective.
5. Carefully reach underneath the dash to remove the bulb socket of the unlighted instrument panels and remove bulb and inspect. NOTE: Be careful not to disconnect any other wires while working beneath the dash.

Principal Author(s): J. Anderson/W. Osland

Procedure: Continued

6. Examine bulb for defectiveness. Check current availability at bulb socket with circuit tester. Replace bulb if defective.

7. When completed, recheck full lighting of instrument panel.

8. Ask the instructor to inspect your completed work.

9. Clean and return all tools and equipment.

10. Clean work area.

11. Take and score the LAP test.

12. Upon successful completion of the LAP test, obtain a copy of Unit Post Test 37.05.06. Answer all of the questions and return the test to the instructor for evaluation.

Student: _____ File Code: 37.04.03.04 & .05

Date: _____ Date Published: 3-5-76

Revised: 9-6-78

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

LAP TEST: TURN SIGNALS/INSTRUMENT LIGHTS

37.04.03.04

1. Instrument lights are connected in a:

   a. series circuit.
   b. series parallel circuit.
   c. parallel circuit.
   d. open circuit.

2. When turning switch is on to indicate turn, the lights are alternately turned on and off by:

   a. an interrupter or flasher.
   b. hand.
   c. a control plate.
   d. a flange pin.

3. Problem: When making a right turn, the right front light flashes and the left rear flashes, you would suspect a:

   a. bad flasher.
   b. wrong type bulb.
   c. poor ground connection.
   d. crossed signal light wires.

37.04.03.05

4. The light rheostat control, on a light switch, has the function of:

   a. a security so you won't burn out your lights.
   b. brightening or dimming of the panel lights.
   c. a cut out relay.
   d. adjusting the current going to your headlights.

6. If only one part of an instrument panel does not light up, it could indicate a:

   a. bad bulb.
   b. bad fuse.
   c. bad rheostat control.
   d. inaccurate gage

LAP TEST ANSWER KEY: TURN SIGNALS/INSTRUMENT LIGHTS

1. C
2. A
3. D
4. B
5. A

Student: _____ File Code: 37.04.03.00

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Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: LIGHTING SYSTEMS

37.04.03.01

1. What causes the diaphragm on a modern horn to vibrate?

   a. horn relay.
   b. circuit breaker in the horn.
   c. air circulating in the lines.
   d. an electromagnet.

2. What is the permissible voltage drop between the battery and the lamp?

   a. 12 volts.
   b. 0.3 volts.
   c. 0.6 volts.
   d. 1.0 volts.

3. Which answer below most likely describes the reason for short head light lift and dim burning head lights?

   a. charging rate too high.
   b. charging rate too low.
   c. loose or corroded connections.
   d. defective battery.

4. How many terminals are on the outboard lamp of a dual head lamp system?

   a. three
   b. four
   c. two
   d. one

5. The diameter of the wire or cable determines its:

   a. strength for wear.
   b. reduction of electric interference.
   c. resistance.
   d. strength for conduction.

37.04.03.02

6. When adjusting #1 headlights on a four-bulb car, you must:

   a. cover #2 headlights.
   b. have car running.
   c. be in a dark room so lights show up on wall.
   d. align your front end.

37.04.03.02 (continued)

7. All headlight adjustments should be made with:

   a. no one in car, but have it sitting level.
   b. a full tank of gas, driver and passenger in car.
   c. the car running.
   d. mechanical aimers.

8. When adjusting #2 beam, your lights are adjusted:

   a. lower and each light is pointing outward on right and left side.
   b. directly under the high beam.
   c. lower and to the left of the high beam.
   d. lower and to the right of the high beam.

9. When inspecting lights and you find something wrong, you should:

   a. use a circuit tester.
   b. check for the proper light bulb.
   c. check the fuse box.
   d. report it on work order.

37.04.03.03

10. If only one unit fails on the brake lights, it would indicate:

   a. there is no current to both tail lights.
   b. the bulb is bad.
   c. the park light is bad because it works in a series circuit.
   d. the fuse is burned out.

11. When checking tail lights and you have none, you should check:

   a. fuses.
   b. relays.
   c. bulbs.
   d. wires.

12. Which is not the cause of head lights frequently burning out:

   a. excessive voltage.
   b. lights left on too long.
   c. loose connections.
   d. excessive charging rate.

37.04.03.04

13. Problem: Both high beams will burn but not the low beam. What is the most likely reason?

   a. faulty dimmer switch.
   b. shorted head light switch.
   c. open head light switch.
   d. loose grounding strap.

37.04.03.04 (continued)

14. When turning switch is on to indicate turn, the lights are alternately turned on and off by:

    a. an interrupter or flasher.
    b. a control plate
    c. hand.
    d. a flange pin.

37.04.03.05

15. The light rheostat control on a light switch has the function of:

    a. adjusting the current going to your headlights.
    b. brightening or dimming of the panel lights.
    c. a security so you won't burn out your lights.
    d. a cut-out relay.

UNIT POST TEST ANSWER KEY: LIGHTING SYSTEMS (A)

1. D
2. C
3. C
4. A
5. C
6. A
7. A
8. D
9. D
10. B
11. A
12. B
13. A
14. A
15. B

Student: _____ File Code: 37.04.03.00 (B)

Date: _____ Date Published: 3-5-76

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Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: LIGHTING SYSTEMS (B)

37.04.03.01

1. The diameter of the wire or cable determines its:

   a. strength for wear.
   b. reduction of electric interference.
   c. resistance.
   d. strength for conduction.

2. How many terminals are on the outboard lamp of a dual head lamp system?

   a. three.
   b. four.
   c. two.
   d. one.

3. Which answer below most likely describes the reason for short head light lift and dim burning head lights?

   a. charging rate too high.
   b. charging rate too low.
   c. loose or corroded connections.
   d. defective battery.

4. What is the permissible voltage drop between the battery and the lamp?

   a. 12 volts.
   b. 0.3 volts.
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   d. 1.0 volts.

5. What causes the diaphragm on a modern horn to vibrate?

   a. horn relay.
   b. circuit breaker in the horn.
   c. air circulating in the lines.
   d. an electromagnet.

37.04.03.02

6. When inspecting lights and you find something wrong, you should:

   a. use a circuit tester.
   b. check for the proper light bulb.
   c. check the fuse box.
   d. report it on work order.

37.04.03.02 (continued)

7. When adjusting #2 beam, your lights are adjusted:

   a. lower and each light is pointing outward on right and left side.
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   c. lower and to the left of the high beam.
   d. lower and to the right of the high beam.

8. All headlight adjustments should be made with:

   a. no one in car, but have it sitting level.
   b. a full tank of gas, driver and passenger in car.
   c. the car running.
   d. mechanical aimers.

9. When adjusting #1 headlights on a four-bulb car, you must:

   a. cover #2 headlights.
   b. have car running.
   c. be in a dark room so lights show up on wall.
   d. align your front end.

37.04.03.03

10. Which is not the cause of head lights frequently burning out:

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    b. lights left on too long.
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37.04.03.04

14. When turning switch is on to indicate turn, the lights are alternately turned on and off by:

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    b. a control plate.
    c. hand.
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37.04.03.04 (continued)

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37.04.03.05

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    a. adjusting the current going to your headlights.
    b. brightening or dimming of the panel lights.
    c. a security so you won't burn out your lights.
    d. a cut-out relay.

UNIT POST TEST ANSWER KEY: LIGHTING SYSTEMS (B)

1. C
2. A
3. C
4. C
5. D
6. D
7. D
8. A
9. A
10. B
11. A
12. B
13. A
14. A
15. B

Student: _____ File Code: 37.04.03.00 (C)

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Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: LIGHTING SYSTEMS (C)

37.04.03.01

1. What causes the diaphragm on a modern horn to vibrate?

   a. horn relay.
   b. circuit breaker in the horn.
   c. air circulating in the lines.
   d. an electromagnet.

2. Which answer below most likely describes the reason for short head light lift and dim burning head lights?

   a. charging rate too high.
   b. charging rate too low.
   c. loose or corroded connections.
   d. defective battery.

3. How many terminals are on the outboard lamp of a dual head lamp system?

   a. three
   b. four
   c. two
   d. one

4. What is the permissible voltage drop between the battery and the lamp?

   a. 12 volts.
   b. 0.3 volts.
   c. 0.6 volts.
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37.04.03.02

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37.04.03.02 (continued)

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   c. the car running.
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   c. check the fuse box.
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   b. have car running.
   c. be in a dark room so lights show up on wall.
   d. align your front end.

37.04.03.03

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   c. bulbs.
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11. If only one unit fails on the brake lights, it would indicate:

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   c. the park light is bad because it works in a series circuit.
   d. the fuse is burned out.

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   b. lights left on too long.
   c. loose connections.
   d. excessive charging rate.

37.04.03.04

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37.04.03.04

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    b. a control plate.
    c. hand.
    d. a flange pin.

37.04.03.05

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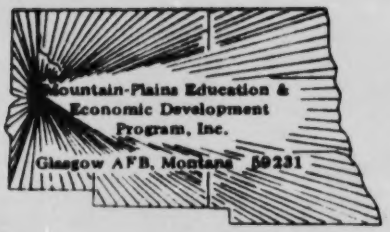
    a. adjusting the current going to your headlights.
    b. brightening or dimming of the panel lights.
    c. a security so you won't burn out your lights.
    d. a cut-out relay.

UNIT POST TEST: LIGHTING SYSTEMS (C)

1. D
2. C
3. A
4. C
5. C
6. D
7. A
8. D
9. A
10. A
11. B
12. B
13. A
14. A
15. B

Student: _____ File Code: 37.04.03.00.B1-5

Date: _____ Date Published: 3/4/76



Family Pay Number: _____ Sex: M F (Circle 1)

UNIT PERFORMANCE TEST: LIGHTING SYSTEMS

OBJECTIVE 1:

Test and repair turn signals.

OBJECTIVE 2:

Test and repair head lights and park lights.

OBJECTIVE 3:

Test and repair tail and brake lights.

OBJECTIVE 4:

Test and repair dash and interior lights.

TASK:

The student will be assigned a vehicle on which he must test and repair all lighting systems on the vehicle.

ASSIGNMENT:

CONDITIONS:

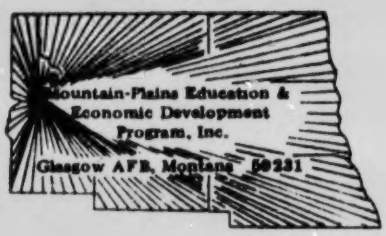
The student may use only those materials provided for the test and perform the test in the auto shop.

RESOURCES:

Service Manual
Time and Parts Manual
Fender Covers
Jacks
Jack Stands
Test Light
Ohmmeter
Volt Meter
Repair parts if needed
Wiring Diagrams
Fuses
Combination Ignition wrench set
Combination Wrench Set
Standard Screwdriver Set
Phillips Screwdriver Set
Feeler gauge - .002 through .025 inch
Hex Key Set
Diagonal Cutting Pliers
Needle Nose Plier
1/4" Drive Socket Set
Ratchet - 3" and 6" extensions - 6" flex handle
Ball Peen hammer
Plastic Tip Hammer
Screw Starter
Chisel and Punch Set
5/32" Pin Punch - 3/16" Solid
Gasket scraper
3/8" Drive Ratchet
3" Extension
Spark Plug Socket
6" Extension
Speed Handle
3/8" Drive Socket Set

Student: _____ File Code: 37.04.03.00.B1-5

Date: _____ Date Published: 3/4/76



Family Pay Number: _____ Sex: M F (Circle 1)

PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory_____ Unsatisfactory_____

	CRITERION Met	Not Met
Objective 1:		
1. Test and repair turn signals.		
Criterion: Must meet manufacturer's specifications.		
Objective 2:		
2. Test and repair park and head lights.		
Criterion: Must meet manufacturer's specifications.		
Objective 3:		
3. Test and repair brake and tail lights.		
Criterion: Must meet manufacturer's specifications.		
Objective 4:		
4. Test and repair dash and interior lights.		
Criterion: Must meet manufacturer's specifications.		
5. Completes test in allotted time.		
Criterion: Meets flat rate time for assigned vehicle.		
Must satisfactorily complete 4 out of 5 line items to pass test.		

File Code: 37.04.04.00.B1-1

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Experience Guide

UNIT: CHARGING SYSTEMS

RATIONALE:

The fundamentals and techniques in this Unit will enable you to diagnose, service and overhaul the components of the charging system.

PREREQUISITES:

None

OBJECTIVES:

Recognize the components and proper operation of the charging system.
Test and overhaul the charging system and components.

RESOURCES:

Printed Materials

Auto Mechanics Fundamentals. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Auto Service and Repair. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Motor's Auto Repair Manual. Motor, The Hearst Corporation. 1972 or equivalent.
Operator's Manual for Test Equipment.

Audio/Visuals

Super 8 Sound Films:

DCA Educational Products, Inc.

Alternator Testing Procedures, Part I--FAA292.
Alternator Testing Procedures, Part II--FAA302.

Universal Education and Visual Arts

Assembling the Alternator--#7816.
Assembling Rotor to Frame and Pulley--#7815.
Dissassembly of the Alternator--#7781.
Installing the Drive End Bearing--#7788.
Installing the Slip Ring End Bearing--#7812.
Removing the Drive End Bearing--#7787.
Removing Slip Ring End Bearing--#7811.
Removing the Pulley--#7782.
Removing the Rotor--#7783.
Replacing Brushes--#7814.
Replacing a Diode--#7813.
Testing Diodes--#7785.
Testing the Stator and Rotor--#7784.
Using the Diode Test--#7786.

Equipment

Automobile with: functioning charging system
defective alternator
defective generator
voltage regulator
AVTC Systems Super 8 mm Instant Film Loop Player
Fender covers
Replacement parts as needed
Test equipment for: charging system
generator
alternator
regulator
Tools, Basic Hand: Chisel and Punch Set
5/32" Pin Punch
3/16" Solid

Gauge, feeler (.002" - .025")

Hammer, ball peen
Hammer, plastic tip
Handle, speed
Hex Key Set

Pliers, diagonal cutting
Pliers, needle nose

Scraper, gasket
Screwdriver, standard (Set)
Screwdriver, phillips (Set)
Screw starter

Socket Set (3/8" drive)
extension (3")
ratchet

Socket Set (1/4" drive)
extension (3")
handle (6" flex)
ratchet

Socket, spark plug
extension (6")

Wrench, combination (Set)
Wrench, combination ignition (Set)

GENERAL INSTRUCTIONS:

This Unit consists of eight Learning Activity Packages (LAPs). Each LAP will provide specific information for completion of a learning activity.

The general procedure for this Unit is as follows:

(1) Read the first assigned Learning Activity Package (LAP).
(2) Begin and complete the first assigned LAP.
(3) Take and score the LAP test.
(4) Turn in the LAP test answer sheet.
(5) Determine the reason for any missed items on the LAP test.
(6) Proceed to and complete the next assigned LAP in the unit.
(7) Complete all required LAPs for the unit by following steps 3 through 6.
(8) Take the unit tests as described in the Unit LEG "Evaluation Procedures".
(9) Proceed to the next assigned unit.

PERFORMANCE ACTIVITIES:

.01 Fundamentals of the Charging System
.02 Testing the Charging System
.03 Fundamentals of the Generator
.04 Repairing the Generator
.05 Fundamentals of the Alternator
.06 Repairing the Alternator
.07 Fundamentals of the Voltage Regulator
.08 Servicing the Voltage Regulator

EVALUATION PROCEDURE:

When pretesting:

1. The student takes the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of the pretest.
3. The student then takes a unit performance test if the unit pretest was successfully completed.
4. Satisfactory completion of the performance test is meeting the criteria listed on the performance test.

When post testing:

1. The student takes a multiple-choice unit post test and a unit performance test.
2. Successful unit completion is meeting the listed criteria for the performance test.

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package (LAP) listed on your Student Progress Record (SPR).

Student: _____ File Code: 37.04.04.00.B1-2

Date: _____ Date Published: 3/17/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT PRETEST: CHARGING SYSTEMS

37.04.04.01.

1. A generator is a device used to take advantage of:

   a. the generator.
   b. magnetic fields.
   c. electric motors.
   d. the left-hand rule.

2. Electric horns use:

   a. relays to make the diaphragm vibrate.
   b. transistors.
   c. electromagnets.
   d. diodes.

3.

4. The strength of the magnetic field and the speed at which the wire moves through a field will:

   a. tell how fast electricity moves.
   b. tell how many revolutions electricity will make in a 1 inch span.
   c. be the direct influence of how much current is produced.
   d. tell how much magnetic attraction it has.

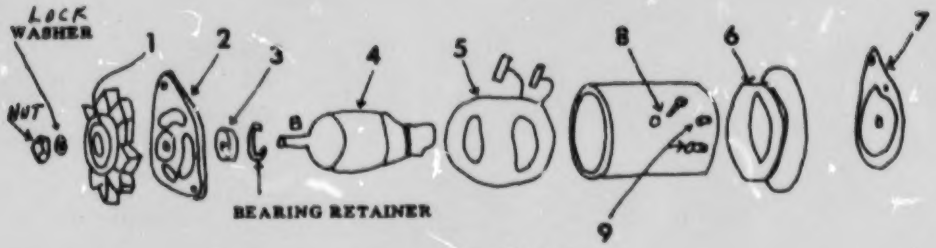
5. The difference between the two DC generator circuits is:

   a. one grounds the field externally and the other grounds internally.
   b. one attaches the insulated brush to the arm and the other doesn't.
   c. one puts out more voltage.
   d. one is larger than the other.

37.04.04.02.

6. What is number 7 in the diagram?*

   a. end plate front.
   b. end plate rear.
   c. dust shield.
   d. commutator.



7. What is number 4 in the diagram?

   a. field coils.
   b. armature.
   c. commutator.
   d. casing.

8. What is number 5 in the diagram?

   a. regulator.
   b. armature.
   c. field coils.
   d. commutator.

9. In a generator the armature is:

   a. the steel jacket to hold the parts.
   b. carbon objects that pick up the current produced by the generator.
   c. the large series of loops or wires located on a shaft.
   d. the series of copper plates located in front near the pulley.

10. What is number 2 in the diagram?

   a. front end plate.
   b. counter balance weight.
   c. dust cover.
   d. brush holder.

*(Adapted from Auto Mechanic Fundamentals, Stockel, Goodheart-Wilcox, 1974, p. 379, Fig. 19-45.)

37.04.04.03.

11. An AC generator, when at idle speed, has a whining sound which could indicate:

    a. a worn V-belt.
    b. a worn bearing.
    c. a faulty diode.
    d. a faulty bushing.

12. Brush howl in a DC generator can result from:

    a. worn field coils.
    b. an out-of-round commutator.
    c. loose brush connections.
    d. a worn armature.

13. When you test an armature for ground, you place one test light prod on the armature core and the other on:

    a. the frame.
    b. the armature terminal.
    c. one of the brushes.
    d. the commutator bar.

14. To check a DC generator for high resistance, you use a(n):

    a. alternator and voltmeter.
    b. voltmeter and regulator.
    c. ammeter and voltmeter.
    d. ammeter and hydrometer.

15. You use a growler for:

    a. checking generator armatures.
    b. checking noise in a generator.
    c. checking field coils.
    d. checking brushes.

37.04.04.04.

16. A transistor voltage regulator:

    a. has no moving parts.
    b. has no diodes.
    c. has no resistance to electric flow.
    d. uses no capacitor.

17. Cars equipped with alternators use:

    a. less electricity because current flows only 1/2 the time.
    b. alternating current.
    c. direct current.
    d. either one depending on how the voltage regulator is set.

37.04.04.04. cont.

18. An alternator differs from a generator in that it:

a. rotates the poles by a loop.
b. needs no fan to cool its inner parts.
c. rotates the loops between poles.
d. has a north and south pole.

19. Before making any tests on the alternator, you should:

a. disconnect the battery ground cable.
b. unplug test equipment.
c. have alternator out of the car.
d. turn ignition switch on to open all circuits.

20. Alternators in automobiles are:

a. one phase AC circuits.
b. two phase AC circuits.
c. three phase AC circuits.
d. four phase AC circuits.

37.04.04.05.

21.

22. If the stop-ring on rotor drive shaft is damaged, you would replace it by:

a. pushing it on the shaft and into the groove.
b. using a snap ring pliers.
c. gently tapping with a plastic.
d. a special took, T65P--10300-B.

23. In a motorola alternator, how many leads are there in a stator?

a. 2.
b. 6.
c. 4.
d. 3.

24. In a field circuit resistance test, when testing each connection along the circuit, you get a drop in voltage; this could indicate:

a. a low output from the battery.
b. a bad stator.
c. a loose or corroded connection.
d. a bad voltage regulator.

37.04.04.05. cont.

25. A diode, in an alternator, has inside of it a:

a. small resistor.
b. small contact points.
c. thin silicon wafer.
d. thin loop of carbon.

37.04.04.06.

26. Circuit breakers in regulators may be used in place of:

a. fuses.
b. ammeters.
c. switches.
d. voltmeters.

27. A current regulator is hooked directly to:

a. the battery.
b. the generator armature circuit.
c. the parallel circuit.
d. the generator.

28. In the typical voltage regulator, there is a cut-out relay. It is used to protect:

a. the distributor.
b. the battery.
c. the coil.
d. the voltage regulator.

29. The most commonly used voltage regulator has how many separate control units?

a. 1.
b. 2.
c. 3.
d. 4.

30. Voltage regulators operate on the principle:

a. that high current causes a tipped down armature and therefore, grounds it.
b. that increasing length of current makes room for overflow of electricity.
c. of electromagnetic force.
d. that high voltage fills up the core-making contact with ground.

37.04.04.07.

31. A fully transistorized regulator:

a. has no moving parts.
b. has no diodes.
c. has no capacitor.
d. doesn't have as long a life span as regulator.

37.04.04.07. cont.

32. When the key in a car is turned on but before the engine is started, the field relay:

    a. is closed.
    b. is activated fully.
    c. is inoperative.
    d. activates the field windings on both sides of the indicator lamp.

33. The alternator regulator differs from the DC generator regulator in what ways?

    a. the DC generator has only a current regulator.
    b. the DC generator has two circuits.
    c. the alternator regulator only has a voltage regulator.
    d. the alternator regulator only has a current regulator.

34. Before proceeding with testing and adjusting the regulator, you should:

    a. take unit out of car.
    b. make sure the battery is half charged only.
    c. make initial visual checks.
    d. thoroughly wash it to insure cleanliness.

35.

37.04.04.08.

36. A current output test measures what in an alternator?

    a. battery storage.
    b. rectifiers output.
    c. amperage.
    d. brush output.

37. It is important to disconnect the ground cable at battery when removing test equipment:

    a. because you may short out the field circuit.
    b. so you won't overcharge your battery.
    c. so your battery can recharge itself.
    d. so you won't get a shock.

38. In a lower contact voltage test, you increase your engine RPM to:

    a. 1,250 RPM.
    b. 5,000 RPM.
    c. 4,400 RPM.
    d. 2,200 RPM.

37.04.04.08. cont.

39. In a voltage regulator test the instrument(s) you use is (are):

    a. a hydrometer.
    b. an ammeter and voltmeter.
    c. a voltmeter and hydrometer.
    d. an ammeter and hydrometer.

40. In an upper contact voltage test when you receive no current reading on the ammeter, it would indicate a low regulator setting or:

    a. inefficient amount of battery output.
    b. a blown fuse wire inside the upper stationary contact.
    c. a loose wire on the voltage regulator.
    d. no connection in the lower stationary contact.

UNIT PRETEST ANSWER KEY: CHARGING SYSTEMS

LAP .01

1. b
2. c
3. d
4. c
5. a

LAP .02

6. c
7. b
8. c
9. c
10. a

LAP .03

11. c
12. b
13. d
14. c
15. a

LAP .04

16. a
17. c
18. a
19. a
20. c

LAP .05

21. c
22. a
23. b
24. c
25. c

LAP .06

26. a
27. b
28. b
29. c
30. c

LAP .07

31. a
32. c
33. c
34. c
35. c

LAP .08

36. c
37. a
38. d
39. b
40. b

File Code: 37.04.04.01.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Fundamentals of the Charging Systems

OBJECTIVE:

Identify the components and proper operation of the charging system.

EVALUATION PROCEDURE:

80% correct on LAP study questions.
Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Auto Mechanics Fundamentals, Stockel, [illegible]

PROCEDURE:

Steps

1. Obtain a text copy and secure a quiet place to study.
2. Read chapter 19, beginning at "Generator" on page 376 to "Direct Current Generator" on page 379.
3. Study the figures 19-35 to 19-40 closely.
4. On separate paper, neatly answer questions 37,38, 39, located on page 405.
5. Upon completion, give answer sheet to the instructor for evaluation.
6. Return text to the proper shelf.
7. Obtain a copy of the LAP test from the instructor. Answer all of the questions and return the test to the instructor for evaluation.
8. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.04.04.01.B1-2

Date: _____ Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

LAP TEST: FUNDAMENTALS OF THE CHARGING SYSTEM

1. What happens when a wire passes through a magnetic field?

   a. the wire will become hot and melt.
   b. the segments of the commutator will break down.
   c. it will change its properties of makeup.
   d. voltage is induced in the wire.

2. An armature in a generator is run by:

   a. electromagnetic force.
   b. electricity.
   c. DC current.
   d. a V-belt from the crankshaft pulley.

3. One of the main functions of the generator is to:

   a. make AC current and DC current together.
   b. recirculate electricity.
   c. meet the needs of the electrical system.
   d. store up as much electricity as possible.

4. The difference between the two DC generator circuits is:

   a. one grounds the field externally and the other grounds internally.
   b. one puts out more voltage.
   c. one is larger than the other.
   d. none of the above.

5. A generator is a device used to take advantage of:

   a. electric motors.
   b. the generator.
   c. the left-hand rule.
   d. magnetic fields.

6.

7.

8. By placing a soft iron core inside the coils of wire carrying an electric current, you will make:

   a. an electromagnet.
   b. an electrocardiogram.
   c. generator.
   d. an electric motor.

9.

10. Electric horns use:

   a. electromagnets.
   b. diodes.
   c. transistors.
   d. heat controlled resistors.

LAP TEST ANSWER KEY: FUNDAMENTALS OF THE CHARGING SYSTEM

1. d
2. d
3. c
4. a
5. d
6. a
7. a
8. a
9. c
10. a

File Code: 37.06.04.02.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Fundamentals of the Generator

OBJECTIVE:

Identify in writing the components and proper operation of the generator.

EVALUATION PROCEDURE:

Score 80% on LAP study questions.
Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Auto Mechanics Fundamentals, Stockel.

PROCEDURE:

Steps

1. Obtain a text copy and secure a quiet place to study.
2. Read chapter 19, beginning at "Direct Current Generator" on page 377 to "Generator Regulator" on page 380.
3. Study the figures 19-41 through 19-47 closely.
4. On separate paper, neatly answer the questions 40-46 located on page 405.
5. When completed, give answer sheet to the instructor for evaluation.
6. Return text to proper shelf.
7. Take and score the LAP test.
8. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.04.04.02.B1-2

Date: _____ Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

LAP TEST: FUNDAMENTALS OF THE GENERATOR

The diagram for the following questions is on the next page.

1. What is number 4 in the diagram?

   a. casing.
   b. field coils.
   c. commutator.
   d. armature.

2. What is number 2 in the diagram?

   a. counter balance weight.
   b. brush holder.
   c. dust cover.
   d. front end plate.

3. What is number 6 in the diagram?

   a. end plate front.
   b. commutator.
   c. dust shield.
   d. end plate rear.

4. What is number 5 in the diagram?

   a. field coils.
   b. commutator.
   c. armature.
   d. regulator.

5. What is number 8 in the diagram?

   a. field coils.
   b. field pole shoe screw.
   c. dust cover.
   d. oiler.

6. In a generator, the armature is:

   a. the steel jacket to hold the parts.
   b. the series of copper plates located in front near the pulley.
   c. carbon objects that pick up the current produced by the generator.
   d. the large series of loops or wires located on a shaft.

7. In the diagram, number 1 is/are the:

   a. pulley.
   b. front bearing.
   c. dust cover.
   d. end plate.

8. What is number 3 in the diagram?

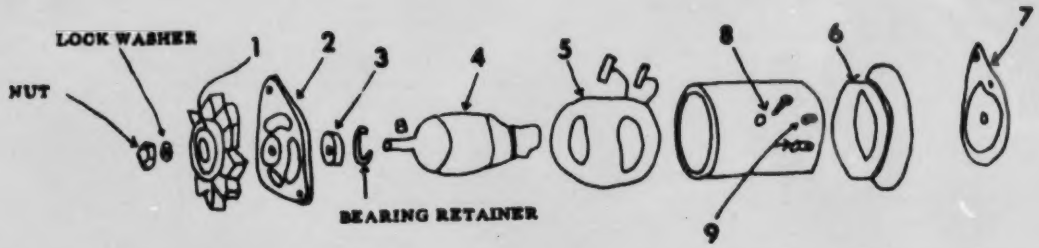
   a. nut.
   b. retainer.
   c. spacer.
   d. bearing.

9. Brushes in a generator are made up of:

   a. any material that will insulate the electric charge.
   b. copper.
   c. carbon.
   d. steel.

10. What is number 9 in the diagram?

   a. armature.
   b. through bolt.
   c. brushes.
   d. "field" terminal.



*(Adapted from Auto Mechanics Fundamentals. Martin W. Stockel, Goodheart-Willcox, 1974. pg. 379, Fig. 19-45.)

LAP TEST ANSWER KEY: FUNDAMENTALS OF THE GENERATOR

1. D
2. D
3. C
4. A
5. B
6. D
7. A
8. D
9. C
10. D

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

File Code: 37.04.04.03.B1-0

Date Published: 3/4/76

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Repairing the Generator

OBJECTIVE:

Diagnose and repair a defective generator.

EVALUATION PROCEDURE:

Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Auto Service and Repair, Stockel.
Motor's Auto Repair Manual.

Automobile with a defective generator
Fender covers
Generator test equipment
Replacement parts as needed
Tools, Basic Hand: (see Unit LEG)

PROCEDURE:

NOTE: Review pages 22-12 through 22-22 in Auto Service and Repair.

1. Place fender covers.
2. Diagnose the generator's problems, using the generator test equipment, following the test equipment operator's manual procedure.
3. Record diagnosed results on work order form.
4. Following the repair manual's generator removal procedure, carefully remove the generator. (Remember: disconnect the battery cable.)
5. Disassemble the generator, using the disassembly procedure of the manual. (The manual will also indicate how and what checks to make.)
6. Replace and repair the defective parts.
7. Re-assemble the generator and re-install into automobile.

Principal Author(s): J. Anderson/W. Osland

8. When installation is completed, test the generator's output and record results on the work order form.
9. Upon satisfactory completion, ask the instructor to evaluate work.
10. Clean and return all tools and equipment.
11. Clean work area.
12. Take and score the LAP test.
13. Upon successful completion, proceed to the next LAP.

Student: _____ File Code: 37.04.04.03.B1-2

Date: _____ Date Published: 7/15/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

LAP TEST: REPAIRING THE GENERATOR

1. In cleaning armature, brushes, and field coils, you:

   a. wipe with a clean cloth.
   b. don't clean.
   c. wash in solvent.
   d. wash in gasoline.

2. Before taking AC or DC generators apart, you should:

   a. check field coils.
   b. put a new one on to see if it works.
   c. make an initial check.
   d. charge battery.

3. To check a DC generator for high resistance, you use a(n):

   a. ammeter and hydrometer.
   b. alternator and voltmeter.
   c. voltmeter and regulator.
   d. ammeter and voltmeter.

4. After turning the commutator down, you should:

   a. clean thoroughly.
   b. place connector into casing.
   c. undercut the mica insulation.
   d. check drive end bearing.

5.

6. When testing a DC generator armature for shorts, if a short is present, the metallic strip will:

   a. ground to armature.
   b. vibrate.
   c. do nothing.
   d. get hot.

7. The two methods used for grounding the generator field circuits are:

   a. AC and DC circuits.
   b. A and B circuits.
   c. alternator and generator.
   d. AL and AC circuits.

8. When you test an armature for ground, you place one test light prod on the armature core and the other on:

   a. one of the brushes.
   b. the frame.
   c. the commutator bar.
   d. the armature terminal.

9. You use a growler for:

   a. checking field coils.
   b. checking brushes.
   c. checking noise in a generator.
   d. checking generator armatures.

10.

LAP TEST ANSWER KEY: REPAIRING THE GENERATOR

1. a
2. c
3. d
4. c
5. [illegible]
6. b
7. b
8. c
9. d
10. [illegible]

File Code: 37.04.04.04.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Fundamentals of the Alternator

OBJECTIVE:

Identify in writing the components and proper operation of the alternator.

EVALUATION PROCEDURE:

80% on LAP study questions.
Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Auto Mechanics Fundamentals, Stockel.

Super 8 Sound Films:

DCA Educational Products, Inc.

Alternator Testing Procedures, Part I--FAA292.
Alternator Testing Procedures, Part II--FAA302.

Universal Education and Visual Arts

Assembling the Alternator--#7816.
Assembling Rotor to Frame and Pulley--#7815.
Dissassembly of the Alternator--#7781.
Installing the Drive End Bearing--#7788.
Installing the Slip Ring End Bearing--#7812.
Removing the Drive End Bearing--#7787.
Removing Slip Ring End Bearing--#7811.
Removing the Pulley--#7782.
Removing the Rotor--#7783.
Replacing Brushes--#7814.
Replacing a Diode--#7813.
Testing Diodes--#7785.
Testing the Stator and Rotor--#7784.
Using the Diode Test--#7786.

Projector

Project PL:
Principal Author(s): J. Anderson/W. Osland

PROCEDURE:

Steps

1. Obtain a text copy and secure a quiet place to study.
2. Read chapter 19, beginning at "Alternating Current (AC) Generator" on page 385 to "Single Unit Regulator" on page 391.
3. Study the figures 19-54 to 19-68B.
4. On separate paper, neatly answer these questions from page 405 and 406; numbers 57, 58, 59, 74.
5. Upon completion, give the answer sheet to the instructor for evaluation.
6. Return text.
7. See the filmstrips listed in the "RESOURCES".
8. Take and score the LAP test.
9. Upon successful completion, proceed to the next LAP.

Student: _____ File Code: 37.04.04.04.B1-2

Date: _____ Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

LAP TEST: FUNDAMENTALS OF THE ALTERNATOR

1. Diode rectifiers are used and act as:

   a. amperage meters.
   b. electrical one-way valves.
   c. circuit breaker.
   d. transistors.

2. A transistor voltage regulator:

   a. has no diodes.
   b. has no moving parts.
   c. uses no capacitor.
   d. has no resistance to electric flow.

3. To rectify current means to:

   a. change from amperage to voltage.
   b. change from voltage to amperage.
   c. change current from DC to AC.
   d. change current from AC to DC.

4. Before making any tests on the alternator, you should:

   a. have alternator out of the car.
   b. unplug test equipment.
   c. turn ignition switch on to open all circuits.
   d. disconnect the battery ground cable.

5. Alternators in automobiles are:

   a. one phase AC circuits.
   b. four phase AC circuits.
   c. two phase AC circuits.
   d. three phase AC circuits.

6. When adjusting a regulator, to prevent accidental grounding, you should:

   a. put a resistor on the regulator.
   b. have ignition switch on to open points.
   c. disconnect battery.
   d. use an insulated tool.

7. Operating on an open circuit, the alternator will:

   a. build up a very high voltage.
   b. polarize an alternator.
   c. not generate.
   d. will ground an alternator.

8. Even though the alternator is turning over, in order to test an alternator, it must be connected to the:

   a. heat sink.
   b. voltage regulator.
   c. capacitor.
   d. battery.

9. The advantage of an alternator in comparison to a generator is:

   a. that it requires less power to operate.
   b. more output of current at lower engine speed.
   c. that it does not have an electric field.
   d. that it can be turned on and off as needed.

10. An open diode will reduce output in an alternator to approximately:

   a. 2 to 8 amps.
   b. 0 to 15 amps.
   c. 10 to 15 amps.
   d. 20 to 30 amps.

LAP TEST ANSWER KEY: FUNDAMENTALS OF THE ALTERNATOR

1. b
2. b
3. d
4. d
5. d
6. d
7. a
8. d
9. b
10. ~~c~~ A

File Code: 37.04.04.05.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Repairing the Alternator

OBJECTIVE:

Use the correct procedure for diagnosis and repair of a defective alternator.

EVALUATION PROCEDURE:

Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Auto Service and Repair, Stockel.
Motor's Auto Repair Manual.

Alternator test equipment
Automobile with a defective alternator
Fender covers
Replacement parts as needed
Tools, Basic Hand: (see Unit LEG)

PROCEDURE:

NOTE: Review filmstrips and pages 22-22 through 22-29 in Auto Service and Repair if necessary.

NOTE: Disconnect negative battery cable first.

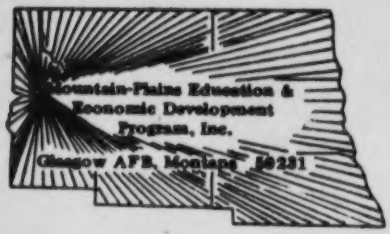
1. Place fender covers.
2. Diagnose alternator problem, using the test procedure found in the alternator test equipment operator's manual.
3. Record test results on work order.
4. Following the repair manual's removal procedure, remove the alternator.
5. Following the disassembly and inspection procedure of the manual, disassemble the alternator.
6. Replace and repair the defective parts.

Principal Author(s): J. Anderson/W. Osland

7. Re-assemble alternator.
8. Re-mount the alternator.
9. Test alternator output and record result on work order.
10. Ask the instructor to check completed work for approval.
11. Clean and return all tools and equipment.
12. Clean work area.
13. Take and score the LAP test.
14. Upon successful completion, proceed to the next LAP.

Student: _____ File Code: 37.04.04.05.B1-2

Date: _____ Date Published: 3/4/76



LAP TEST: REPAIRING THE ALTERNATOR

1. In a field circuit resistance test, when testing each connection along the circuit you get a drop in voltage, this could indicate:

   a. a low output from the battery.
   b. a bad voltage regulator.
   c. a bad stator.
   d. a loose or corroded connection.

2. When splitting stator from alternator, to prevent damage to stator windings, you should not insert screwdriver more than:

   a. 1/2 inch.
   b. 1/4 inch.
   c. 1/16 inch.
   d. 1/8 inch.

3. If the stop-ring on the rotor drive shaft is damaged, you would replace it by:

   a. a special tool, T65P--10300-B.
   b. pushing it on the shaft and into the groove.
   c. gently tapping with a plastic tool.
   d. using a snap ring pliers.

4. A diode, in an alternator, has inside of it:

   a. small contact points.
   b. a small resistor.
   c. a thin loop of carbon.
   d. a thin silicon wafer.

5. An ammeter reading, when giving a ratio test, should not be above 2·8 and 3·2. If it is, it would indicate:

   a. the stator is bad.
   b. the insulator is bad.
   c. shorted diodes.
   d. shorted windings.

6. To prevent any damage to the alternator when making any test connection, you should:

   a. remove battery cable.
   b. turn switch to on position.
   c. adjust voltage regulator.
   d. take off your voltage regulator.

7. To remove the heat sink and insulator on an alternator, you:

   a. remove DC output terminal nuts and remove terminal.
   b. remove with a pulley-puller.
   c. separate the three stator load wires to prevent shorting.
   d. remove the heat sink diodes first.

8. When you disassemble an alternator, you should mark the two end housings with the:

   a. field coils.
   b. field terminal.
   c. stator.
   d. rotor.

9. The voltage at which the alternator operates is determined by:

   a. the speed the engine is turning.
   b. how low your battery is.
   c. the regulator adjustment.
   d. the number of accessories the alternator has to handle.

10. Diodes may be tested by using an:

   a. voltmeter.
   b. amperage meter.
   c. ohmmeter.
   d. ·20 volt test lamp.

LAP TEST ANSWER KEY: REPAIRING THE ALTERNATOR

1. d
2. c
3. b
4. d
5. d
6. a
7. a
8. c
9. c
10. c

File Code: 37.04.04.06.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Fundamentals of the Voltage Regulator

OBJECTIVE:

Identify the components and proper operation of the voltage regulator.

EVALUATION PROCEDURE:

Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Auto Mechanics Fundamentals, Stockel.

PROCEDURE:

Steps

1. Obtain text copy and secure a quiet place to study.
2. Read chapter 19, beginning at "Generator Regulator" on page 381 to "Alternating Current (AC) Generator" on page 385. Also read "Single Unit Regulator" on page 390 to "Starter System" on page 391.
3. Study figures 19-48A to 19-53 and figures 19-68B to 19-69A.
4. On separate paper, neatly answer questions 47 through 55 on page 405.
5. When completed, give answer sheet to the instructor.
6. Read "Mechanic is Responsible" page 405 (think it over carefully).
7. Return text to shelf.
8. Take and score the LAP test.
9. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.04.04.06.B1-2

Date: _____ Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

LAP TEST: FUNDAMENTALS OF THE VOLTAGE REGULATOR

1. By using bimetallic hinge strips on the circuit breaker and current regulator in cold weather, it is possible to:

   a. reduce regulator coil magnetic efficiency.
   b. limit current flow.
   c. stop all current to the battery.
   d. allow increased current flow

2. The most commonly used voltage regulator has how many separate control units?

   a. 4
   b. 1
   c. 3
   d. 2

3. Voltage regulators operate on the principle:

   a. of electromagnetic force.
   b. that increasing length of current makes room for overflow of electricity.
   c. that high current causes a tipped down armature and therefore, grounds it.
   d. that high voltage fills up the core-making contact with ground.

4. You would polarize a generator:

   a. after installation.
   b. if it is a 12 volt generator.
   c. after you break it in for a few days.
   d. before installation.

5. Circuit breakers in regulators may be used in place of:

   a. switches.
   b. ammeters.
   c. fuses.
   d. voltmeters.

6. In a voltage regulator, the electromagnet with the:

   a. fewest loops or turns controls voltage, fine wire protects battery.
   b. fine wire controls current, heavy wire controls voltage.
   c. fine wire controls voltage, heavy wire controls current.
   d. fewest loops or turns controls current, heavy wire controls voltage.

7. A current regulator is hooked directly to:

   a. the generator armature circuit.
   b. the parallel circuit.
   c. the battery.
   d. none of the above.

8. In the typical voltage regulator, there is a cut-out relay. It is used to protect:

   a. the distributor.
   b. the coil.
   c. the battery.
   d. the voltage regulator.

9. The difference between a double contact voltage regulator and a single contact voltage regulator is:

   a. shorter service with lower generator output.
   b. shorter service with higher generator output.
   c. longer service with higher generator output.
   d. allows lower field currents with higher generator speeds.

10. When generator is not operating, the position of the armatures in the voltage regulator is:

   a. cut-out relay is closed but the other two are open.
   b. all armatures are closed.
   c. all armatures are open.
   d. cut-out relay is open but the other two relays are not.

LAP TEST ANSWER KEY: FUNDAMENTALS OF THE VOLTAGE REGULATOR

1. d
2. c
3. a
4. a
5. c
6. c
7. a
8. c
9. c
10. d

File Code: 37.04.04.07.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Servicing the Voltage Regulator

OBJECTIVE:

Diagnose, adjust and test a voltage regulator.

EVALUATION PROCEDURE:

Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Motor's Auto Repair Manual.

Automobile with a voltage regulator
Fender covers
Regulator testing equipment
Tools, Basic Hand: (see Unit LEG)

PROCEDURE:

NOTE: Review pages 22-29 through 22-32 in Auto Service and Repair. Read pages 22-33 through 22-41 in Auto Service and Repair.

NOTE: Use extreme caution in making adjustment to prevent damage to the electrical parts while the battery cables are connected. It is best to remove one battery cable before making regulator adjustments.

1. Place fender covers.
2. Diagnose regulator problem using regulator testing equipment and operator's manual.
3. Refer to repair manual for regulator output specifications. Record specifications on work order.
4. Follow the manual's procedure for making the correct regulator adjustments needed to correct the malfunction.
5. Test regulator output to insure that it is now meeting the required specifications. Record results on work order.

Principal Author(s): J. Anderson/W. Osland

6. Ask the instructor to evaluate work. Explain how and what adjustments were made to correct the malfunctioning regulator.

7. Clean and return all tools and equipment.

8. Clean work area.

9. Take and score the LAP test.

10. Upon successful completion of the LAP test, obtain a copy of Unit Post Test 37.05.04. Answer all of the questions and return the test to the instructor for evaluation.

11. Upon successful completion of unit test, proceed to the next unit.

Student: _____ File Code: 37.04.04.07.B1-2

Date: _____ Date Published. 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

LAP TEST: SERVICING THE VOLTAGE REGULATOR

1. Cut-out relay closing voltage on a voltage regulator may be set:

   a. by a special tool.
   b. it cannot be set.
   c. an adjusting screw.
   d. first, removing it from car.

2. To clean the points on a voltage regulator, either hard or soft, you use:

   a. 400 silicon carbide paper.
   b. a special point file.
   c. suitable material for hardness of points.
   d. a fine hard carbon file.

3. Before adjusting cut-out relay air gap on a voltage regulator, you would:

   a. disconnect battery.
   b. turn ignition key off.
   c. file the points.
   d. turn ignition key on.

4. A fully transistorized regulator:

   a. has no moving parts.
   b. doesn't have as long a life span as a regular regulator.
   c. has no diodes.
   d. has no capacitor.

5. A partially transistorized regulator has what function?

   a. takes less current to function.
   b. cuts down on current loss.
   c. assists the regular voltage regulator.
   d. lets the regulator have a longer life.

6. A fully transistorized regulator is often called a:

   a. "diode regulator"
   b. "trans"
   c. "static"
   d. "capacitor regulator"

7. Before making each test on the voltage regulator, you must:

   a. normalize it.
   b. disconnect it.
   c. polarize it.
   d. take off the cover.

8. What definitely affects regulator voltage control?

   a. ambient temperature.
   b. the charge the voltage regulator has.
   c. the number of amps in a voltage regulator.
   d. the amount of current put out by a DC generator or alternator.

9. The alternator regulator differs from the DC generator regulator in what way?

   a. the alternator regulator only has a voltage regulator.
   b. the DC generator has two circuits.
   c. the DC generator has only a current regulator.
   d. the alternator regulator only has a current regulator.

10. When the key in a car is turned on but before the engine is started, the field relay:

   a. is closed.
   b. activates the field windings on both sides of the idicator lamp.
   c. is inoperative.
   d. is activated fully.

LAP TEST ANSWER KEY: SERVICING THE VOLTAGE REGULATOR

1. c
2. c
3. a
4. [illegible]
5. [illegible]
6. c
7. a
8. a
9. a
10. c

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Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Testing the Charging System

OBJECTIVES:

Recognize the correct procedure for testing and diagnosing the condition of an operating charging system.

Test and diagnose the condition of an operating charging system.

EVALUATION PROCEDURE:

Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Auto Service and Repair, Stockel.
Motor's Auto Repair Manual.
Operator's Manual for Test Equipment

Automobile with functioning charging system
Fender covers
Tools, Basic Hand: (see Unit LEG)

PROCEDURE:

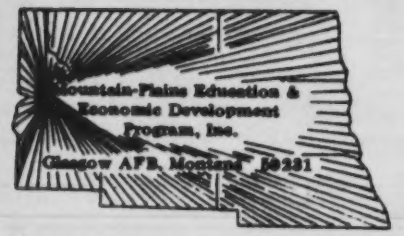
NOTE: Read pages 22-10 through 22-42 in Auto Service and Repair.

1. Place fender covers.
2. Test charging system output with test equipment. (Follow operator's test procedure from operator's manual.)
3. Record results on work order.
4. Refer to repair manual for the charging system's output specifications. Record on work order.
5. If adjustments are necessary, perform them according to the manual's adjustment procedure.
6. Record adjustments made.
7. Ask the instructor to evaluate your completed work. Explain the adjustments performed.
8. Clean and return all tools and equipment.
9. Clean work area.
10. Take and score the LAP test.
11. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 3?.04.04.08.B1-2

Date: _____ Date Published: 3/4/76



LAP TEST: TESTING THE CHARGING SYSTEM

1. Excessive resistance in the regulator wiring circuit will cause:

   a. the voltmeter reading to remain constant.
   b. fluctuation in the ammeter.
   c. fluctuation in the voltmeter.
   d. an over output of electricity.

2. In a charging circuit resistance test, the voltmeter with 10 amps flowing through a circuit should not exceed:

   a. ·5 volts.
   b. ·4 volts.
   c. ·3 volts.
   d. ·6 volts.

3. In an upper contact voltage test when you receive no current reading on the ammeter, it would indicate a low regulator setting or:

   a. a blown fuse wire inside the upper stationary contact.
   b. a loose wire on the voltage regulator.
   c. no connection in the lower stationary contact.
   d. inefficient amount of battery output.

4. A current output test measures what in an alternator?

   a. battery storage.
   b. amperage output.
   c. brush output.
   d. rectifiers output.

5. You would measure temperature of regulator by holding a thermometer:

   a. on top of the regulator cover.
   b. on the inside cover of the regulator.
   c. on the radiator to tell how hot it is.
   d. 1/4 inch from regulator cover.

LAP TEST ANSWER KEY: TESTING THE CHARGING SYSTEM

1. b
2. c
3. a
4. b
5. d

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Mountain-Plains Education & Economic Development Program, Inc.
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UNIT POST TEST: CHARGING SYSTEMS A

37.04.04.01.

1. What happens when a wire passes through a magnetic field?

   a. the segments of the commutator will break down.
   b. the wire will become hot and melt.
   c. it will change its properties of makeup.
   d. voltage is induced in the wire.

2. Electricity produces:

   a. transistors.
   b. relays.
   c. magnetism.
   d. current.

3. One of the main functions of the generator is to:

   a. meet the needs of the electrical system.
   b. recirculate electricity.
   c. make AC current and DC current together.
   d. store up as much electricity as possible.

4. In the left-hand rule for coils, your thumb will point to which pole?

   a. north.
   b. always south.
   c. east.
   d. always west.

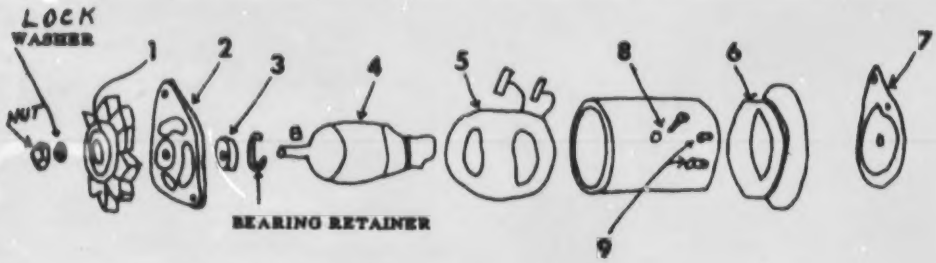
5. If a wire in a magnetic field is part of a closed circuit, current will:

   a. not flow.
   b. destroy the wiring system.
   c. flow in a circle.
   d. ground out.

37.04.04.02.

6. A generator produces voltage and:

   a. DC current only.
   b. AC or DC current.
   c. AC current only.
   d. carbon crystals which change into DC current.



7. In the diagram, number 1* is:

   a. fins.
   b. dust cover.
   c. pulley.
   d. end plate.

8. What is number 7 in the diagram?

   a. pulley.
   b. field coils.
   c. brush end plate.
   d. front end plate.

9. What is number 3 in the diagram?

   a. spacer.
   b. retainer.
   c. bearing.
   d. bushing.

10. What is number 9 in the diagram:

   a. armature.
   b. through bolt.
   c. brushes.
   d. terminals.

*(Adapted from Auto Mechanic Fundamentals, Stockel, Goodheart-Wilcox, 1974, p. 379, Fig. 19-45.)

37.04.04.03.

11. When testing a DC generator armature for shorts, if a short is present, the metallic strip will:

    a. do nothing.
    b. ground to armature.
    c. get hot.
    d. vibrate.

13. In cleaning armature, brushes, and field coils, you:

    a. don't clean.
    b. wipe with a clean cloth.
    c. wash in solvent.
    d. wash in gasoline.

14. After turning the commutator down, you should:

    a. place connector into casing.
    b. clean thoroughly.
    c. check drive end bearing.
    d. undercut the mica insulation.

15. An electrical unbalance in an AC generator is caused by:

    a. voltage regulator.
    b. a bad battery.
    c. an open diode.
    d. a worn capacitor.

37.04.04.04.

16. Diode rectifiers are used and act as:

    a. transistors.
    b. electrical one-way valves.
    c. circuit breakers.
    d. amperage meters.

17. Even though the alternator is turning over, in order to test an alternator, it must be connected to the:

    a. voltage regulator.
    b. battery.
    c. heat sink.
    d. capacitor.

37.04.04.04. cont.

18. A shorted diode will reduce output in an alternator to:

    a. 10 to 15 amps.
    b. 15 to 30 amps.
    c. 0 to 15 amps.
    d. 2 to 8 amps.

19. High resistance in an alternator is caused from:

    a. a bad ballast resistor.
    b. a bad voltage regulator.
    c. a faulty wire.
    d. too much output from the battery.

20. Operating on an open circuit the alternator will:

    a. build up a very high voltage.
    b. not generate.
    c. will ground an alternator.
    d. polarize an alternator.

37.04.04.05.

21. An ammeter reading, when giving a ratio test, should not be above 2.8 and 3.2. If it is, it would indicate:

    a. shorted diodes.
    b. shorted windings.
    c. the insulator is bad.
    d. the stator is bad.

22. When you disassemble an alternator, you should mark the two end housings with the:

    a. field coils.
    b. field terminal.
    c. stator.
    d. rotor.

23. To prevent any damage to the alternator when making a test connection, you should:

    a. adjust voltage regulator.
    b. turn switch to on position.
    c. take off your voltage regulator.
    d. remove battery cable.

24. To remove the heat sink and insulator on an alternator, you:

    a. remove DC output terminal nuts and remove terminal.
    b. separate the three stator load wires to prevent shorting.
    c. remove the heat sink diodes first.
    d. remove with a pulley-puller.

37.04.04.05. cont.

25. The voltage at which the alternator operates is determined by:

    a. the regulator adjustment.
    b. the speed the engine is turning.
    c. the number of accessories the alternator has to handle.
    d. how low your battery is.

37.04.04.06.

26. The directional flow of current leaving the generator is defined as:

    a. polarity.
    b. alternating current.
    c. flow of electricity.
    d. residual magnetism.

27. Diode rectifiers in a single unit voltage regulator prevent current flow back into the:

    a. battery.
    b. alternator.
    c. field terminals.
    d. junction block.

28. When the generator is <u>not</u> operating, the position of the armatures in the voltage regulator is:

    a. all armatures are open.
    b. cut-out relay is closed but the other two are open.
    c. cut-out relay is open but the other two relays are not.
    d. all armatures are closed.

29. In a voltage regulator, the electromagnet with the:

    a. fine wire controls current, heavy wire controls voltage.
    b. fewest loops or turns controls current, fine wire controls voltage.
    c. fewest loops or turns controls voltage, fine wire protects battery.
    d. fine wire controls voltage, heavy wire controls current.

30. When the flow of current through the core shunt coil is high enough, it will:

    a. strengthen the generator magnetic field.
    b. charge the battery to capacity.
    c. pull armature down and separate points.
    d. pull armature down and contact points.

37.04.04.07.

31. Before making each test on the voltage regulator, you must:

    a. take off the cover.
    b. normalize it.
    c. polarize it.
    d. disconnect it.

37.04.04.07. cont.

32. Before adjusting cut-out relay air gap on a voltage regulator, you would:

a. file the points.
b. disconnect battery.
c. turn ignition key on.
d. turn ignition key off.

33. What definitely affects regulator voltage control?

a. the amount of current put out by a DC generator or alternator.
b. ambient temperature.
c. the number of amps in a voltage regulator.
d. the charge the battery has.

34. A partially transistorized regulator has what function?

a. cuts down on current loss.
b. lets the regulator have a longer life.
c. assists the regular voltage regulator.
d. takes less current to function.

35. To clean the points on a voltage regulator, either hard or soft, you use:

a. a fine hard carbon file.
b. a special point file.
c. suitable material for hardness of points.
d. 400 silicon carbide paper.

37.04.04.08.

36. In a charging circuit resistance test, the voltmeter with 10 amps flowing through a circuit should not exceed:

a. ·5 volts.
b. ·3 volts.
c. :4 volts.
d. ·6 volts.

37. It is important to disconnect the ground cable at battery when removing test equipment:

a. because you may short out the field circuit.
b. so you won't get a shock.
c. so your battery can recharge itself.
d. so you won't overcharge your battery.

38. You would measure temperatures of regulator by holding a thermometer:

a. on the radiator to tell how hot it is.
b. on the inside cover of the regulator.
c. 1/4 inch from regulator cover.
d. on top of the regulator cover.

37.04.04.08. cont.

39. In a lower contact voltage test, you increase your engine RPM to:

a. 1,250 RPM.
b. 4,400 RPM.
c. 5,000 RPM.
d. 2,200 RPM.

40. In a voltage regulator test the instrument(s) you use is (are):

a. an ammeter and voltmeter.
b. an ammeter and hydrometer.
c. a voltmeter and hydrometer.
d. a hydrometer.

UNIT POST TEST ANSWER KEY: CHARGING SYSTEMS (A)

LAP .01
1. d
2. c
3. a
4. a
5. c

LAP .02
6. b
7. c
8. c
9. c
10. d

LAP .03
11. d
12. a
13. b
14. d
15. c

LAP .04
16. b
17. b
18. a
19. c
20. a

LAP .05
21. b
22. c
23. d
24. a
25. a

LAP .06
26. a
27. b
28. c
29. d
30. c

LAP .07
31. b
32. b
33. b
34. c
35. c

LAP .08
36. b
37. a
38. c
39. d
40. a

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Mountain-Plains Education & Economic Development Program, Inc.
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UNIT POST TEST: CHARGING SYSTEMS (B)

37.04.04.01

1. If a wire in a magnetic field is part of a closed circuit, current will:

   a. not flow
   b. destroy the wiring system
   c. flow in a circle
   d. ground out

2. In the left-hand rule for coils, your thumb will point to which pole?

   a. north
   b. always south
   c. east
   d. always west

3. One of the main functions of the generator is to:

   a. meet the needs of the electrical system
   b. recirculate electricity
   c. make AC current and DC current together
   d. store up as much electricity as possible

4. Electricity produces:

   a. transistors
   b. relays
   c. magnetism
   d. current

5. What happens when a wire passes through a magnetic field?

   a. the segments of the commutator will break down
   b. the wire will become hot and melt
   c. it will change its properties of makeup
   d. voltage is induced in the wire

37.04.04.02

6. What is number 9 in the diagram:

   a. armature
   b. through bolt
   c. brushes
   d. terminals

37.04.04.02 cont.

7. What is number 3 in the diagram?

   a. spacer
   b. retainer
   c. bearing
   d. bushing

8. What is number 7 in the diagram?

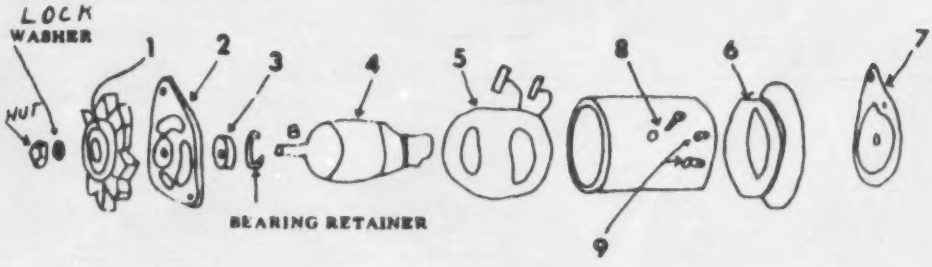
   a. pulley
   b. field coils
   c. brush end plate
   d. front end plate

9. In the diagram, number 1 is:

   a. fins
   b. dust cover
   c. pulley
   d. end plate

10. A generator produces voltage and:

   a. DC current only
   b. AC or DC current
   c. AC current only
   d. carbon crystals which change into DC current



(Adapted from Auto Mechanic Fundamentals, Stockel, Goodheart-Wilcox, 1974, p. 379, Fig. 19-45.)

37.04.04.03

11. An electrical unbalance in an AC generator is caused by:

   a. voltage regulator
   b. a bad battery
   c. an open diode
   d. a worn capacitor

12. After turning the commutator down, you should:

   a. place connector into casing
   b. clean thoroughly
   c. check drive end bearing
   d. undercut the mica insulation

37.04.04.03 cont.

13. In cleaning armature, brushes, and field coils, you:

    a. don't clean
    b. wipe with a clean cloth
    c. wash in solvent
    d. wash in gasoline

14. When checking the resistance of a DC generator with an output of 20 amps, the voltage of the voltmeter should not exceed:

    a. 0.3 volts
    b. 15 volts
    c. 30 volts
    d. 0.5 volts

15. When testing a DC generator armature for shorts, if a short is present, the metallic strip will:

    a. do nothing
    b. ground to armature
    c. get hot
    d. vibrate

37.04.04.04

16. Operating on an open circuit the alternator will:

    a. build up a very high voltage
    b. not generate
    c. will ground an alternator
    d. polarize an alternator

17. High resistance in an alternator is caused from:

    a. a bad ballast resistor
    b. a bad voltage regulator
    c. a faulty wire
    d. too much output from the battery

18. A shorted diode will reduce output in an alternator to:

    a. 10 to 15 amps
    b. 15 to 30 amps
    c. 0 to 15 amps
    d. 2 to 8 amps

19. Even though the alternator is turning over, in order to test an alternator, it must be connected to the:

    a. voltage regulator
    b. battery
    c. heat sink
    d. capacitor

37.04.04.04 cont.

20. Diode rectifiers are used and act as:

    a. transistors
    b. electrical one-way valves
    c. circuit breakers
    d. amperage meters

37.04.04.05

21. The voltage at which the alternator operates is determined by:

    a. the regulator adjustment
    b. the speed the engine is turning
    c. the number of accessories the alternator has to handle
    d. how low your battery is

22. To remove the heat sink and insulator on an alternator, you:

    a. remove DC output terminal nuts and remove terminal
    b. separate the three stator load wires to prevent shorting
    c. remove the heat sink diodes first
    d. remove with a pulley-puller

23. To prevent any damage to the alternator when making a test connection, you should:

    a. adjust voltage regulator
    b. turn switch to on position
    c. take off your voltage regulator
    d. remove battery cable

24. When you disassemble an alternator, you should mark the two end housings with the:

    a. field coils
    b. field terminal
    c. stator
    d. rotor

25. An ammeter reading, when giving a ratio test, should not be above 2.8 and 3.2. If it is, it would indicate:

    a. shorted diodes
    b. shorted windings
    c. the insulator is bad
    d. the stator is bad

37.04.04.06

26. When the flow of current through the core shunt coil is high enough, it will:

    a. strengthen the generator magnetic field
    b. charge the battery to capacity
    c. pull armature down and separate points
    d. pull armature down and contact points

37.04.04.06 cont.

27. In a voltage regulator, the electromagnet with the:

    a. fine wire controls current, heavy wire controls voltage
    b. fewest loops or turns controls current, fine wire controls voltage
    c. fewest loops or turns controls voltage, fine wire protects battery
    d. fine wire controls voltage, heavy wire controls current

28. When the generator is not operating, the position of the armatures in the voltage regulator is:

    a. all armatures are open
    b. cut-out relay is closed but the other two are open
    c. cut-out relay is open but the other two relays are not
    d. all armatures are closed

29. Diode rectifiers in a single unit voltage regulator prevent current flow back into the:

    a. battery
    b. alternator
    c. field terminals
    d. junction block

30. The directional flow of current leaving the generator is defined as:

    a. polarity
    b. alternating current
    c. flow of electricity
    d. residual magnetism

37.04.04.07

31. To clean the points on a voltage regulator, either hard or soft, you use:

    a. a fine hard carbon file
    b. a special point file
    c. suitable material for hardness of points
    d. 400 silicon carbide paper

32. A partially transistorized regulator has what function?

    a. cuts down on current loss
    b. lets the regulator have a longer life
    c. assists the regular voltage regualtor
    d. takes less current to function

33. What definitely affects regular voltage control?

    a. the amount of current put out by a DC generator or alternator
    b. ambient temperature
    c. the number of amps in a voltage regulator
    d. the charge the battery has

37.04.04.07 cont.

34. Before adjusting cut-out relay air gap on a voltage regulator, you would:

a. file the points
b. disconnect battery
c. turn ignition key on
d. turn ignition key off

35. Before making each test on the voltage regulator, you must

a. take off the cover
b. normalize it
c. polarize it
d. disconnect it

37.04.04.08

36. In a voltage regulator test the instrument(s) you use is (are):

a. an ammeter and voltmeter
b. a ammeter and hydrometer
c. a voltmeter and hydrometer
d. a hydrometer

37. In a lower contact voltage test, you increase your engine RPM to:

a. 1,250 RPM
b. 4,400 RPM
c. 5,000 RPM
d. 2,200 RPM

38. You would measure temperatures of regulator by holding a thermometer:

a. on the radiator to tell how hot it is:
b. on the inside cover of the regulator
c. ¼ inch from regulator cover
d. on the top of the regulator cover

39. It is important to disconnect the ground cable at battery when removing test equipment:

a. because you may short out the field circuit
b. so you won't get a shock
c. so your battery can recharge itself
d. so you won't overcharge your battery

40. In a charging circuit resistance test, the voltmeter with 10 amps flowing through a circuit should not exceed:

a. .5 volts
b. .3 volts
c. .4 volts
d. .6 volts

UNIT POST TEST ANSWER KEY: CHARGING SYSTEMS (B)

LAP 01

1. C
2. A
3. A
4. C
5. D

LAP 02

6. D
7. C
8. C
9. C
10. B

LAP 03

11. C
12. D
13. B
14. A
15. D

LAP 04

16. A
17. C
18. A
19. B
20. B

LAP 05

21. A
22. A
23. D
24. C
25. B

LAP 06

26. C
27. D
28. C
29. B
30. A

LAP 07

31. C
32. C
33. B
34. B'
35. B

LAP 08

36. A
37. D
38. C
39. A
40. B

Student: _____ File Code: 37.04.04.00.C1-2 (C)

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UNIT POST TEST: CHARGING SYSTEMS (C)

37.04.04.01

1. In the left-hand rule for coils, your thumb will point to which pole?

   a. north
   b. always south
   c. east
   d. always west

2. One of the main functions of the generator is to:

   a. meet the needs of the electrical system
   b. recirculate electricity
   c. make AC current and DC current together
   d. store up as much electricity as possible

3. If a wire in a magnetic field is part of a closed circuit, current will:

   a. not flow
   b. destroy the wiring system
   c. flow in a circle
   d. ground out

4. What happens when a wire passes through a magnetic field?

   a. the segments of the commutator will break down
   b. the wire will become hot and melt
   c. it will change its properties of makeup
   d. voltage is induced in the wire

5. Electricity produces:

   a. transistors
   b. relays
   c. magnetism
   d. current

37.04.04.02

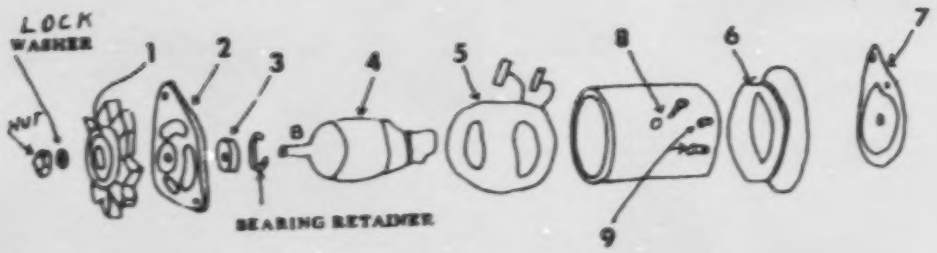
What is number 7 in the diagram?

   a. pully
   b. field coils
   c. brush end plate
   d. front end plate

37.04.04.02 cont.

7. A generator produces voltage and:

   a. DC current only
   b. AD or DC current
   c. AC current only
   d. carbon crystals which change into DC current



*(Adapted from Auto Mechanic Fundamentals, Stockel, Goodheart-Wilcox, 1974, p. 379, Fig. 19-45.)

8. What is number 3 in the diagram?

   a. spacer
   b. retainer
   c. bearing
   d. bushing

9. What is number 9 in the diagram:

   a. armature
   b. through bolt
   c. brushes
   d. terminals

10. In the diagram, number 1 is:

   a. fins
   b. dust cover
   c. pulley
   d. end plate

37.04.04.03

11. When testing a DC generator armature for shorts, if a short is present, the metallic strip will:

   a. do nothing
   b. ground to armature
   c. get hot
   d. vibrate

12. In cleaning armature, brushes, and field coils, you:

   a. don't clean
   b. wipe with a clean cloth
   c. wash in solvent
   d. wash in gasoline

37.04.04.03 cont.

13. An electrical unbalance in an AC generator is caused by:

    a. voltage regulator
    b. a bad battery
    c. an open diode
    d. a worn capacitor

14. When checking the resistance of a DC generator with an output of 20 amps, the voltage of the voltmeter should not exceed:

    a. 0.3 volts
    b. 15 volts
    c. 30 volts
    d. 0.5 volts

15. After turning the commutator down, you should:

    a. place connector into casing
    b. clean thoroughly
    c. check drive end bearing
    d. undercut the mica insulation

37.04.04.04

16. Diode rectifiers are used and act as:

    a. transistors
    b. electrical one-way valves
    c. circuit breakers
    d. amperage meters

17. High resistance in an alternator is caused from:

    a. a bad ballast resistor
    b. a bad voltage regulator
    c. a faulty wire
    d. too much output from the battery

18. A shorted diode will reduce output in an alternator to:

    a. 10 to 15 amps
    b. 15 to 30 amps
    c. 0 to 15 amps
    d. 2 to 8 amps

19. Operating on an open circuit the alternator will:

    a. build up a very high voltage
    b. not generate
    c. will ground an alternator
    d. polarize an alternator

37.04.04.04 cont.

20. Even though the alternator is turning over, in order to test an alternator, it must be connected to the:

    a. voltage regulator
    b. battery
    c. heat sink
    d. capacitor

37.04.04.05

21. An ammeter reading, when giving a ratio test, should not be above 2.8 and 3.2. If it is, it would indicate:

    a. shorted diodes
    b. shorted windings
    c. the insulator is bad
    d. the starter is bad

22. To remove the heat sink and insulator on an alternator, you:

    a. remove DC output terminal nuts and remove terminal
    b. separate the three stator load wires to prevent shorting
    c. remove the heat sink diodes first
    d. remove with a pulley-puller

23. When you disassemble an alternator, you should mark the two end housing with the:

    a. field coils
    b. field terminal
    c. stator
    d. rotor

24. To prevent any damage to the alternator when making a test connection, you should:

    a. adjust voltage regulator
    b. turn switch to on position
    c. take off your voltage regulator
    d. remove battery cable

25. The voltage at which the alternator operates is determined by:

    a. the regulator adjustment
    b. the speed the engine is turning
    c. the number of accessories the alternator has to handle
    d. how low your battery is

37.04.04.06

26. The directional flow of current leaving the generator is defined as:

    a. polarity
    b. alternating current
    c. flow of electricity
    d. residual magnetism

37.04.04.06 cont.

27. When the flow of current through the core shunt coil is high enough, it will:

    a. strengthen the generator magnetic field
    b. charge the battery to capacity
    c. pull armature down and separate points
    d. pull armature down and contact points

28. Diode rectifiers in a single unit voltage regulator prevent current flow back into the:

    a. battery
    b. alternator
    c. field terminals
    d. junction block

29. In a voltage regulator, the electromagnet with the:

    a. fine wire controls current, heavy wire controls voltage
    b. fewest loops or turns controls current, fine wire controls voltage
    c. fewest loops or turns controls voltage, fine wire protects battery
    d. fine wire controls voltage, heavy wire controls current

30. When the generator is not operating, the position of the armatures in the voltage regulator is:

    a. all armatures are open
    b. cut-out relay is closed but the other two are open
    c. cut-out relay is open but the other two relays are not
    d. all armatures are closed

37.04.04.07

31. What definitely affects regulator voltage control?

    a. the amount of current put out by a DC generator or alternator
    b. ambient temperature
    c. the number of amps in a voltage regulator
    d. the charge the battery has

32. Before adjusting cut-out relay air gap on a voltage regulator, you would:

    a. file the points
    b. disconnect battery
    c. turn ignition key on
    d. turn ignition key off

33. To clean the points on a voltage regulator, either hard or soft, you use:

    a. a fine hard carbon file
    b. a special point file
    c. suitable material for hardness of points
    d. 400 silicon carbide paper

37.04.04.07 cont.

34. Before making each test on the voltage regulator, you must:

a. take off the cover
b. normalize it
c. polarize it
d. disconnect it

35. A partially transistorized regulator has what function?

a. cuts down on current loss
b. lets the regulator have a longer life
c. assists the regular voltage regulator
d. takes less current to function

37.04.04.08

36. In a charging circuit resistance test, the voltmeter with 10 amps flowing through a circuit should not exceed:

a. .5 volts
b. .3 volts
c. .4 volts
d. .6 volts

37. You would measure temperatures of regulator by holding a thermometer:

a. on the radiator to tell how hot it is
b. on the inside cover of the regulator
c. ½ inch from regulator cover
d. on top of the regulator cover

38. In a voltage regulator test the instrument(s) you use is (are):

a. an ammeter and voltmeter
b. an ammeter and hydrometer
c. a voltmeter and hydrometer
d. a hydrometer

39. It is important to disconnect the ground cable at battery when removing test equipment:

a. because you may short out the field circuit
b. so you won't get a shock
c. so your battery can recharge itself
d. so you won't overcharge your battery

40. In a lower contact voltage test, you increase your engine RPM to:

a. 1,250 RPM
b. 4,400 RPM
c. 5,000 RPM
d. 2,200 RPM

UNIT POST TEST ANSWER KEY: CHARGING SYSTEMS (C)

LAP 01

1. A
2. A
3. C
4. D
5. C

LAP 02

6. C
7. B
8. C
9. D
10. C

LAP 03

11. D
12. B
13. C
14. A
15. D

LAP 04

16. B
17. C
18. A
19. A
20. B

LAP 05

21. B
22. A
23. C
24. D
25. A

LAP 06

26. A
27. C
28. B
29. D
30. C

LAP 07

31. B
32. B
33. C
34. B
35. C

LAP 08

36. B
37. C
38. A
39. A
40. D

Student: _____ File Code: 37.04.04.00.B1-5

Date: _____ Date Published: 3/4/76

Family Pay Number: _____ Sex: M F (Circle 1)

UNIT PERFORMANCE TEST: CHARGING SYSTEMS.

OBJECTIVE 1:

Test charging system.

OBJECTIVE 2:

Repair alternator.

OBJECTIVE 3:

Service regulator.

TASK:

The student will be assigned a vehicle on which he must test and repair the charging system.

ASSIGNMENT:

CONDITIONS:

The student may use only those materials provided for the test and perform the test in the auto shop.

RESOURCES:

Service Manuals
Parts and Time Manuals
Repair Parts if Needed
Diode Tester
Ohmmeter
"Sun" Volt-amp Tester 28
Fender covers
Alternator Repair Tools
Combination Ignition wrench set
Combination Wrench Set
Standard Screwdriver Set
Phillips Screwdriver Set
Feeler gauge - .002 through .025 inch
Hex Key Set
Diagonal Cutting Pliers
Needle Nose Plier
1/4" Drive Socket Set
Ratchet - 3" and 6" extensions - 6" flex handle
Ball Peen hammer
Plastic Tip Hammer
Screw Starter
Chisel and Punch Set
5/32" Pin Punch - 3/16" Solid
Gasket scraper
3/8" Drive Ratchet
3" Extension
Spark Plug Socket
6" Extension
Speed Handle
3/8" Drive Socket Set

Student: _____ File Code: 37.04.04.00.81-5

Date: _____ Date Published: 3/4/76

Family Pay Number: _____ Sex: M F (Circle 1)

PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory_____ Unsatisfactory_____

	CRITERION Met	Not Met
Objective 1:		
1. Test charging system.		
Criterion: Compares to manufacturer's specifications.		
Objective 2:		
2. Remove and repair alternator.		
Criterion: Follows service manual procedures and		
meets manufacturer's specifications.		
Objective 3:		
3. Services voltage regulator.		
4. Tests charging system.		
Criterion: Must meet manufacturer's specifications.		
5. Completes test in allotted time.		
Criterion: Meets flat rate time on assigned vehicle.		
The student must satisfactorily complete 4 out of 5 line		
items to pass test.		

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Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Experience Guide

UNIT: STARTING SYSTEM

RATIONALE:

The fundamentals and techniques in this Unit will enable you to diagnose and overhaul the components of the starting system.

PREREQUISITES:

None

OBJECTIVES:

Identify the components and operation of the starting system.
Overhaul starting system components.

RESOURCES:

Printed Materials

Auto Mechanics Fundamentals. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Motor's Auto Repair Manual. Motor, The Hearst Corporation. 1972 or equivalent.

Audio/Visuals

Super 8 Sound Films:

DCA Educational Products, Inc.

Starter Current Draw Test--FAA282.

Equipment

Defective starters: Chrysler gear reduction starter
Delco
Ford
Defective starter replacement parts as needed
Fender covers
Jumper cables
Sand paper
Test equipment
AVT Systems Super 8 mm Instant Film Loop Player
Tools, Basic Hand: Chisel and Punch Set
5/32" Pin Punch
3/16" Solid

Gauge, feeler (.002" - .025")

Principal Author(s): W. Osland

Resources: Equipment: Continued

Hammer, ball peen
Hammer, plastic tip
Handle, speed
Hex Key Set

Pliers, diagonal cutting
Pliers, needle nose

Scraper, gasket
Screwdriver, standard (Set)
Screwdriver, phillips (Set)
Screw starter

Socket Set (3/8" drive)
  extension (3")
  ratchet

Socket Set (1/4" drive)
  extension (3")
  handle (6" flex)
  ratchet

Socket, spark plug
  extension (6")

Wrench, combination (Set)
Wrench, combination ignition (Set)

Voltmeter

GENERAL INSTRUCTIONS:

This Unit consists of five Learning Activity Packages (LAPs). Each LAP will provide specific information for completion of a learning activity.

The general procedure for this unit is as follows:

(1) Read the first assigned Learning Activity Package (LAP).
(2) Begin and complete the first assigned LAP.
(3) Take and score the LAP test.
(4) Turn in the LAP test answer sheet.
(5) Determine the reason for any missed items on the LAP test.
(6) Proceed to and complete the next assigned LAP in the unit.
(7) Complete all required LAPs for the unit by following steps 3 through 6.
(8) In this Unit, there are some LAPs that have tests combined with other LAP tests. These combined tests are taken after completing the last LAP covered by the test.
(9) Take the unit tests as described in the Unit LEG "Evaluation Procedures".
(10) Proceed to the next assigned unit.

PERFORMANCE ACTIVITIES:

.01 Fundamentals of the Starting Motor
.02 Overhauling Chrysler Starter
.03 Overhauling Delco Starter
.04 Overhauling Ford Starter
.05 Starting System Wiring

EVALUATION PROCEDURE:

When pretesting:

1. The student takes the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of the pretest.
3. The student then takes a unit performance test if the unit pretest was successfully completed.
4. Satisfactory completion of the performance test is meeting the criteria listed on the performance test.

When post testing:

1. The student takes a multiple choice unit post test and a unit performance test.
2. Successful unit completion is meeting the listed criteria for the performance test.

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package (LAP) listed on your Student Progress Record (SPR).

Student: _____ File Code: 37.04.05.00.B1-2

Date: _____ Date Published: 3/17/76

Mountain-Plains Education & Economic Development Program, Inc. Glasgow AFB, Montana 59231

UNIT PRETEST: STARTING SYSTEMS

37.04.05.01.

1. In the diagram, what is number 7?

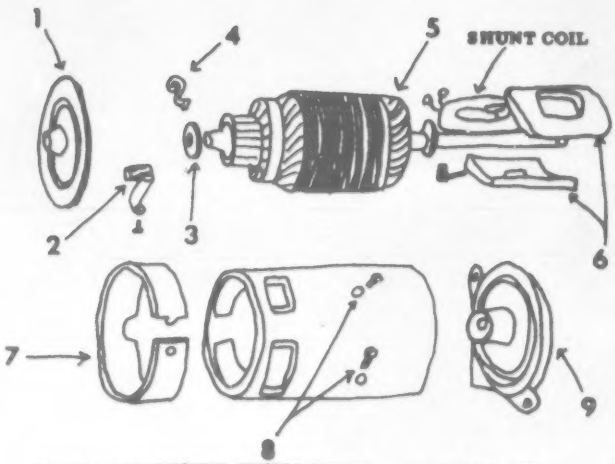
   a. front plate.
   b. coil.
   c. cover band.
   d. starter ring gear.

2. In the diagram*, what is number 4?

   a. dowel.
   b. brush spring.
   c. brush.
   d. frame.

3. In the diagram, what is number 2?

   a. brush.
   b. windings of brass.
   c. drive pinion.
   d. bronze bearing.



4. In the diagram, what is number 6?

   a. armature housing.
   b. overrunning clutches.
   c. field coils.
   d. armatures.

5. The ends of an armature loop are fastened:

   a. to commutator segments.
   b. directly to the brush end plate.
   c. directly to the ends of another armature loop.
   d. to copper brushes.

*(Adapted from Auto Mechanic Fundamentals, Stockel, Goodheart-Wilcox, 1974, p. 393, Fig. 16-74.)

37.04.05.02.

6. In a typical solenoid switch there are:

   a. four windings.
   b. two windings.
   c. three windings.
   d. one winding.

7.

37.04.05.03.

8. When cleaning an overrunning clutch drive:

   a. you would soak the parts in a solvent and then use a brush to clean them.
   b. you would disassemble and clean parts individually.
   c. you never soak them in a solvent.
   d. you would use 00 sand paper.

9. Overrunning clutch drives:

   a. are hard to determine if they are in bad shape.
   b. are easy to replace while starter is torn apart.
   c. cannot be overhauled in the field.
   d. never wear out.

10. Spring tension on the brushes in a Ford auto-lite starter should not be less than:

   a. 45 ounces.
   b. 3 pounds.
   c. 30 ounces.
   d. 5 pounds.

37.04.05.04.

11. On a Delco-Remy starter, some solenoids have a terminal which is identified with the letter "R" which is:

   a. designed to put less electricity to the armature.
   b. not important if you don't have a six volt system.
   c. connected to the battery side of the ignition coil.
   d. a way of returning extra electricity to battery.

12. Failure for a Delco starter to mesh at low temperatures is because:

   a. the grease is dirty in the starter.
   b. the roller bearings are dry.
   c. the armature is iced-up.
   d. you have too heavy a lubricant.

37.04.05.04. cont.

13.

14. On a Delco starter with enclosed shift lever, adjustment of the pinion clearance is done:

    a. by the commutator.
    b. by the brush end plate.
    c. by the actuating lever return spring.
    d. it's not, there is no adjustment.

15. During a free speed test on a Delco starter, a tachometer:

    a. will let you know how fast your engine is going.
    b. tells you how fast your brushes have to work to produce electricity.
    c. has no function in this test.
    d. measures armature revolutions per minute.

37.04.05.05.

16. The recommended correction procedure when the lights go out when the starter switch is closed is to:

    a. clean battery connections to starter.
    b. correct the grounding out of a solenoid.
    c. check your wiring diagram on your regulator.
    d. charge the battery.

17. If the lights dim considerably as the starter switch is closed and the starter operates slowly, your problem is:

    a. that you have an open circuit in your solenoid.
    b. a low battery or some mechanical condition in engine or starter.
    c. probably that of too much heat on your starter armature.
    d. too long cables causing a high voltage drop to your starter.

18. On a Chrysler direct drive starter, you install a thrust washer on the commutator end of armature shaft:

    a. to obtain a good contact with commutator.
    b. to obtain .010 minimum end play.
    c. for a spacer.
    d. no end play in commutator.

37.04.05.05. cont.

19. To determine the cause of abnormal operation in the starter motor,:

    a. you should test it with a hydrometer.
    b. you should alternate the current going to the starter.
    c. you should test for specific gravity.
    d. it should be submitted to a no-load and torque test.

20. Prior to putting in a reassembled starter, you should:

    a. always bench test it.
    b. paint casing to prevent rust.
    c. spray a plastic spray over it.
    d. be sure the crankshaft rotation is correct with starter.

UNIT PRETEST ANSWER KEY: STARTING SYSTEMS

LAP .01

1. c
2. b
3. a
4. c
5. a

LAP .02

6. b
7. a

LAP .03

8. c
9. c
10. a

LAP .04

11. c
12. d
13. d
14. d
15. d

LAP .05

16. a
17. b
18. b
19. d
20. a

File Code: 37.04.05.01.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Fundamentals of the Starting Motor

OBJECTIVE:

Identify in writing the components and proper operation of the starting motor.

EVALUATION PROCEDURE:

80% correct answers on LAP study questions.
Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Auto Mechanics Fundamentals, Stockel.
Filmstrip:
Starter Current Draw Test--FAA282.

PROCEDURE:

Steps

1. Obtain a text copy and secure a quiet place to study.
2. From chapter 19, read "Starter System", page 391 to "Horn" on page 398.
3. Study the figures 19-70 through 19-87A.
4. On separate paper, neatly answer the questions from page 405, questions 60 through 66.
5. Upon completion give answer sheet to instructor for evaluation.
6. Return text to shelf.
7. View filmstrip #AA 282 "Starter Current Draw Test."
8. Return filmstrip.
9. Take and score the LAP test.
10. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.04.05.01.B1-2

Date: _____ Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
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LAP TEST: FUNDAMENTALS OF THE STARTING MOTOR

1. In the diagram, what is number 6?

   a. armatures.
   b. overrunning clutches.
   c. armature housing.
   d. field coils.

2. The solenoid has what function?

   a. to increase power or torque of the starter.
   b. to act as a safety precaution so you won't burn up the starter.
   c. to draw current from the starter and returns it to the battery.
   d. to direct battery current to the starter.

3. In the diagram, what is number 7?

   a. starter ring gear.
   b. coil.
   c. front plate.
   d. cover band.

4. The ends of an armature loop are fastened:

   a. to commutator segments.
   b. to copper brushes.
   c. directly to the brush end plate.
   d. directly to the ends of another armature loop.

5. When operating the starter motor, the maximum operation is:

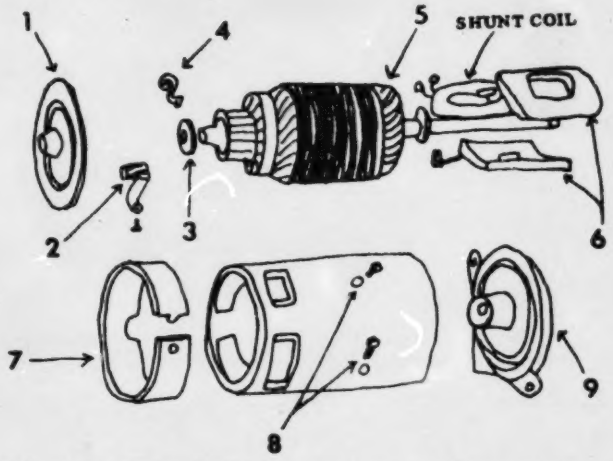
   a. not more than 20 or 30 seconds.
   b. not more than 10 or 20 seconds.
   c. it doesn't matter that much.
   d. not more than a minute.

6. In the diagram, what is number 4?

   a. brush spring.
   b. brush.
   c. frame.
   d. dowel.

7. In the diagram, what is number 8?

   a. mounting screws.
   b. pole shoe screws.
   c. brush screws.
   d. terminal screws.



*(Adapted from Auto Mechanics Fundamentals, Martin W. Stockel, Goodheart-Willcox Company, Inc., 1974, p. 393, Fig. 16-76.)

8. In order to provide a means for the starting motor to turn the flywheel, a large ring gear is either welded to the flywheel or:

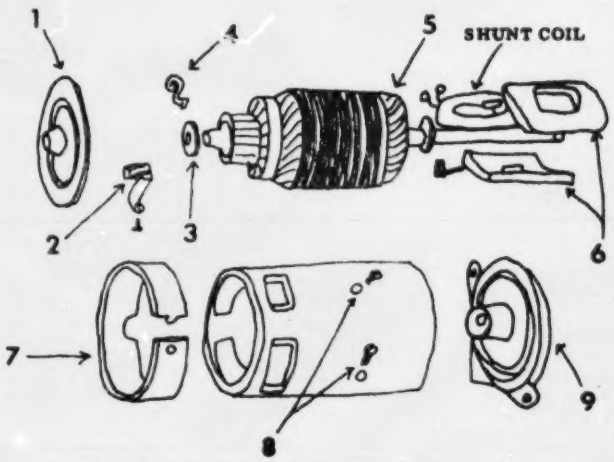
   a. center punched to hold gear on to flywheel.
   b. soldered onto the flywheel.
   c. screwed into the flywheel.
   d. heated and shrunk onto the flywheel.

9. In the diagram, what is number 1?

   a. front end plate.
   b. armature plate.
   c. brush end plate.
   d. dust protector.

10. In the diagram, what is number 5?

   a. frame.
   b. coil.
   c. armature.
   d. ring pinion gear.



*(Adapted from Auto Mechanics Fundamentals, Martin W. Stockel, Goodheart-Willcox Company, Inc., 1974, P. 393, Fig. 16-76.)

LAP TEST ANSWER KEY: FUNDAMENTALS OF THE STARTING MOTOR

1. D
2. D
3. D
4. A
5. A
6. A
7. B
8. D
9. C
10. C

File Code: 37.04.05.02.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Starting Wiring System

OBJECTIVE:

Recognize the correct procedure for inspecting and testing starting system wiring.

EVALUATION PROCEDURE:

Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Motor's Auto Repair Manual.

Automobile needing starting wiring system checked
Fender covers
Replacement parts as needed
Tools, Basic Hand: (see Unit LEG)
Voltmeter

PROCEDURE:

NOTE: Refer to repair manual for diagnosis procedure if necessary.

1. Place fender covers.
2. Inspect the battery clamp connections. Clean with baking soda and water if corrosion is present. Clean connection with battery connection cleaner tools.
3. Inspect the ground cable and connection for frayed or loose parts.
4. Inspect the positive cable for insulation breakage, frayed parts, and loose connection.
5. Replace defective parts.
6. Inspect the electrical wire leads at the starter solenoid for tightness and proper insulation.
7. Inspect the cable retainers for proper alignment away from moving parts or very hot areas.

Principal Author(s): J. Anderson/W. Osland

8. Perform a starter voltage drop test using a voltmeter. Record and compare readings to the manufacturer's specifications.
9. Record all results on work order.
10. Upon completion ask the instructor to evaluate work.
11. Clean and return all tools and equipment.
12. Clean work area.
13. Take and score the LAP test.
14. Upon successful completion, proceed on to the next LAP.

Student: _____ File Code: 37.04.05.02.B1-2

Date: _____ Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
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LAP TEST: STARTING SYSTEM WIRING

3. The winding(s) in a solenoid switch:

   a. doesn't produce a magnetic field.
   b. acts as a ground.
   c. produces a magnetic field.
   d. regulates the flow of electricity from the generator.

4. When the solenoid switch chatters, it is a sign of:

   a. too much electricity going through the circuit.
   b. a discharged battery.
   c. a bad voltage regulator.
   d. reversed wiring on the solenoid.

5. In a typical solenoid switch there are:

   a. three windings.
   b. four windings.
   c. five windings.
   d. two windings.

LAP TEST ANSWER KEY: STARTING SYSTEM WIRING

1.
2.
3. c
4. b
5. d

File Code: 37.04.05.03.B2-0

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Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Overhauling Ford Starter

OBJECTIVE:

Diagnose and overhaul a Ford starter.

EVALUATION PROCEDURE:

Eight correct responses to ten-item multiple-choice objective test

RESOURCES:

Motor's Auto Repair Manual.

Fender covers
Ford starter needing repair
Replacement parts as needed
Test equipment
Tools, Basic Hand: (see Unit LEG)

PROCEDURE:

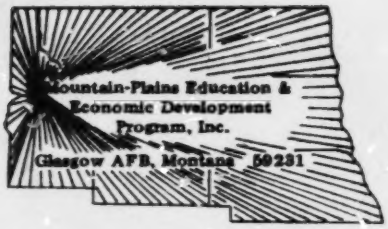
Steps

1. Place fender covers.
2. Diagnose starter problem using the repair manual.
3. Record starter problem on work order.
4. Remove starter. Use removal procedure recommended by the manual.
5. Disassemble and inspect starter components. Use the proper procedure from the manual and make all the required checks.
6. Replace defective parts and reassemble, following the manual's re-assembly procedure, the starter.
7. "Bench-test" the starter when completed and before re-installation using battery jumper cables and a battery.
8. Re-install the starter.
9. Upon completion ask the instructor to evaluate work.
10. Clean and return all tools and equipment.
11. Clean work area.
12. When completed with this LAP, take and score the LAP test.
13. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.04.05.03.B1-2

Date: _____ Date Published: 3/4/76



LAP TEST: FORD STARTER

1. In your diagnosis you would record starter problems on:

   a. your work order.
   b. your repair manual by the page the trouble is on.
   c. the air cleaner so you won't lose it.
   d. your mind because you can remember it easily.

2. When cleaning an overrunning clutch drive:

   a. You would disassemble and clean parts individually.
   b. you never soak them in a solvent.
   c. you would use 00 sand paper.
   d. you would soak them in a solvent and then use a brush to clean them.

3. The solenoid assembly unit on a Ford auto-lite solenoid actuated starter is mounted:

   a. to the overrunning clutch.
   b. to the field coils.
   c. to the cover bands.
   d. to a flange on the starter drive.

4. With the bendix type drive in a starter, incomplete engagement of the pinion with the ring gear is:

   a. not adjustable.
   b. the reason they made split collars for starters.
   c. a common cause of tooth damage.
   d. allowable because of the end play in the pinion shaft.

5. In a starter drive unit, a worn or chipped ring gear or starter pinion is:

   a. the cause of most trouble in a starter.
   b. something that never happens in a starter.
   c. very hard to find when it goes bad.
   d. the usual cause for noisy operations.

LAP TEST ANSWER KEY: FORD STARTER

1. a
2. b
3. d
4. c
5. d

File Code: 37.04.05.04.81-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Overhauling Delco Starter

OBJECTIVE:

Diagnose and overhaul a Delco starter.

EVALUATION PROCEDURE:

Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Motor's Auto Repair Manual.

Delco starter needing repair
Fender covers
Jumper cables
Replacement parts as needed

Sand paper
Test equipment
Tools, Basic Hand: (see Unit LEG)

PROCEDURE:

Steps

NOTE: Remove the negative battery cable first during any starter removal. Test the starter after re-assembly for proper operation.

1. Place fender covers.
2. From the repair manual, use the diagnosis procedure to locate the starter problem. Record on the work order.
3. Following the removal procedure, remove the starter. Take note of the wire connections.
4. Refer to the manual to disassemble the starter. The manual will tell you what tests to perform for accurate repair, plus the proper method of replacing parts for the starter. NOTE: The commutator may be cleaned with 00 sand paper. The insulator pieces may be cleaned with a sharp narrow tool.

Principal Author(s): J. Anderson/W. Osland

5. Re-assemble the starter following the re-assembly procedure. NOTE: After assembly, bench test the starter to insure satisfactory operation by use of jumper cables and a vehicle battery. This test will save time and inconvenience of having to remove the starter again if it fails to operate.

6. Re-install the starter.

7. Upon completion, ask the instructor to evaluate work.

8. Clean and return all tools and equipment.

9. Clean work area.

10. Take and score the LAP test.

11. Upon successful completion, proceed to the next LAP.

Student: _____ File Code: 37.04.05.04.B1-2

Date: _____ Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

LAP TEST: OVERHAULING DELCO STARTER

1. On a Delco-Remy starter with enclosed shift lever, the solenoid is attached:

   a. by a dust band.
   b. on the drive end housing.
   c. on the armature.
   d. on the overrunning clutch.

2. Prior to installing an assembled starter, you should:

   a. bench test it.
   b. make it water proof.
   c. paint it.
   d. check your wiring on your coil.

3. On a Delco-Remy starter, some solenoids have a terminal which is identified with the letter "R", which is:

   a. not important if you don't have a six volt system.
   b. a way of returning extra electricity to battery.
   c. designed to put less electricity to the armature.
   d. connected to the battery side of the ignition coil.

4. During a free speed test on a Delco starter, a tachometer:

   a. has no function in this test.
   b. measures armature revolutions per minute.
   c. will let you know how fast your engine is going.
   d. tells you how fast your brushes have to work to produce electricity.

5. On a Delco starter with enclosed shift lever, adjustment of the pinion clearance is done:

   a. it's not, there is no adjustment.
   b. by the brush end plate.
   c. by the commutator.
   d. by the actuating lever return spring.

6. Failure for a Delco starter to mesh at low temperatures is because:

   a. the grease is dirty in the starter.
   b. the roller bearings are dry.
   c. the armature is iced-up.
   d. you have too heavy of a lubricant.

7. The Delco-Remy starter with enclosed shift lever has an overrunning clutch:

   a. which keeps the pinion gear engaged with flywheel.
   b. which is operated by a solenoid.
   c. which is the only starter which has one.
   d. which is exposed to weather elements.

8. The purpose of an "R" terminal on a Delco starter is:

   a. to act as a safety valve for the armature.
   b. to provide high ignition coil output for starting engine.
   c. to return excess amounts of electricity to the battery.
   d. only important if you have a six volt system.

9.

10. The commutator may be cleaned by:

   a. emery cloth.
   b. washing it with a light solvent.
   c. 00 sand paper.
   d. a wire brush.

LAP TEST ANSWER KEY: OVERHAULING DELCO STARTER

1. b
2. a
3. d
4. b
5. a
6. d
7. b
8. b
9. ~~a~~
10. c

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Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Overhauling Chrysler Starter

OBJECTIVE:

Diagnose and overhaul a Chrysler gear reduction starter.

EVALUATION PROCEDURE:

Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Motor's Auto Repair Manual.

Defective Chrysler gear reduction starter
Fender covers
Necessary testing equipment
Replacement parts as needed
Tools, Basic Hand: (see Unit LEG)

PROCEDURE:

Steps

1. Place fender covers.
2. Diagnose starter problem before removal. NOTE: It is always helpful to diagnose the problem before removal and disassembly so it is known what defective part to look for or to plan to replace. Chrysler starters vary greatly from other starters, so care must be taken in disassembly.
3. Locate in the manual the section on starter repair.
4. Follow the removal procedure closely for easy and quick removal. (Be sure to disconnect the negative battery cable first.)
5. Following the disassembly and inspection procedure, carefully repair the starter.

Principal Author(s): J. Anderson/W. Osland

6. Re-assemble the starter following the re-assembly procedure. Re-install the starter. NOTE: Always "bench-test" the starter after assembly with jumper cables before installing to insure satisfactory operation and save time and possible inconvenience of having to remove the starter again if inoperable.

7. When the starter is re-installed, and operates satisfactorily, ask the instructor to evaluate work.

8. Clean and return all tools and equipment.

9. Clean work area.

10. Take and score the LAP test.

11. Upon successful completion, proceed to the next LAP.

Student: _____ File Code: 37.04.05.05.B1-2

Date: _____ Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

LAP TEST: OVERHAULING CHRYSLER STARTER

1. If the lights stay bright but there is no cranking action, the problem:

   a. indicates a closed circuit.
   b. indicates an open circuit.
   c. may be that of corrosion on the battery cables.
   d. is that your battery output is low.

2. The recommended correction procedure, when the lights go out when the starter switch is closed, is:

   a. to check your wiring diagram on your regulator.
   b. replace solenoid.
   c. to correct the grounding out of a solenoid.
   d. to clean battery connections to starter.

3. Prior to putting in a reassembled starter, you should:

   a. be sure the crankshaft rotation is correct with starter.
   b. always bench test it.
   c. spray a plastic spray over it.
   d. paint casing to prevent rust.

4. When reassembling, you should lubricate armature shaft and splines:

   a. with a light grease.
   b. with S.A.E 10W 40.
   c. with either a or d.
   d. with graphite.

5. When diagnosing a starter problem with the lights burning and they go out as the starter switch is closed, it would indicate:

   a. the wiring is reversed on the regulator.
   b. a poor connection between battery and starter.
   c. overcharged battery.
   d. the solenoid is grounding out.

6. On a Chrysler direct drive starter you install a thrust washer on commutator end of armature shaft:

   a. to obtain .010 minimum end play.
   b. to obtain no end play in commutator.
   c. for a spacer.
   d. to obtain a good contact with commutator.

7. In a Chrysler direct drive starter the brush holders are:

   a. lifetime guaranteed.
   b. standard among all types of starter motors.
   c. not serviced individually.
   d. serviced individually.

8. To determine the cause of abnormal operation in the starter motor:

   a. you should test it with a hydrometer.
   b. it should be submitted to a no-load and torque test.
   c. you should alternate the current going to the starter.
   d. you should test for specific gravity.

9. When diagnosing starter motor problems, you should:

   a. make several preliminary checks in other areas.
   b. examine the starter closely to see if it is hot.
   c. first check to see if your brushes are burnt out.
   d. take it out of the car and place it in a clean work area.

10. If the lights dim considerably as the starter switch is closed and the starter operates slowly, your problem is:

    a. a low battery or some mechanical condition in engine or starter.
    b. that you have an open circuit in your solenoid.
    c. probably that of too much heat on your starter armature.
    d. too long cables causing a high voltage drop to your starter.

LAP TEST ANSWER KEY: OVERHAULING CHRYSLER STARTER

1. b
2. d
3. b
4. c
5. b
6. a
7. c
8. b
9. a
10. a

Student: _____ File Code: 37.04.05.00.C1-2

Date: _____ Date Published: 3/17/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: STARTING SYSTEMS A

37.04.05.01.

1. When the starter motor armature begins to turn, the starter gear:

   a. moves out of its magnetic field into another field.
   b. remains in a neutral position.
   c. moves out and engages the ring gear.
   d. releases from the flywheel.

2. In an armature loop, each side of the 2-sided loop:

   a. will set up a magnetic field and will have attracting fields.
   b. will be insulated with a rubber mount.
   c. will set up a magnetic field and will have no charge or be neutral.
   d. will set up a magnetic field and each side will have opposing fields.

3. In the diagram*, what is number 9?

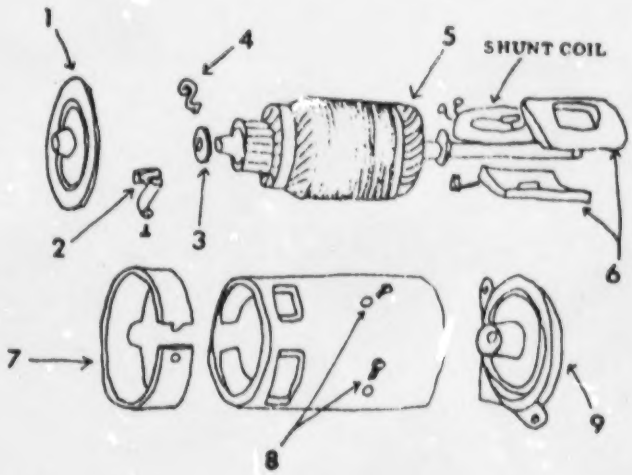
   a. brush end plate.
   b. rear end plate.
   b. front end plate.
   d. thrust washer plate.

4. In the diagram, what is number 5?

   a. coil.
   b. frame.
   c. ring pinion gear.
   d. armature.

5. In the diagram, what is number 3?

   a. drive pinion.
   b. coil.
   c. dust seal.
   d. thrust washer.



*Adapted from Auto Mechanic Fundamentals, Stockel, Goodheart-Wilcox, 1974, p. 393, Fig. 16-76.)

37.04.05.02.

6. A 12 volt solenoid switch is energized by the battery through:

   a. a plunger in the starting motor.
   b. a separate starting switch.
   c. a separate winding in the armature.
   d. voltage regulator.

7. The winding(s) in a solenoid switch:

   a. regulate the flow of electricity from the generator.
   b. produce a magnetic field.
   c. doesn't produce a magnetic field.
   d. acts as a ground.

8. When the solenoid switch chatters, it is a sign of:

   a. too much electricity going through the circuit.
   b. a bad voltage regulator.
   c. reversed wiring on the solenoid.
   d. a discharged battery.

37.04.05.03.

9.

10. With the bendix type drive in a starter, incomplete engagement of the pinion with the ring gear is:

    a. the reason they made split collars for starters.
    b. allowable because of the end play in the pinion shaft.
    c. cannot be adjusted.
    d. a common cause of tooth damage.

37.04.05.04.

11. Prior to installing an assembled starter, you should:

    a. paint it.
    b. make it water proof.
    c. bench test it.
    d. check your wiring on your coil.

12. The commutator may be cleaned by:

    a. 00 sand paper.
    b. washing it with a light solvent.
    c. emery cloth.
    d. a wire brush.

37.04.05.04. cont.

13. The Delco-Remy starter with enclosed shift lever has an overrunning clutch:

    a. which is exposed to weather elements.
    b. which is operated by a solenoid.
    c. which keeps the pinion gear engaged with flywheel.
    d. and is the only starter that has one.

14. On a Delco Remy starter with enclosed shift lever, the solenoid is attached:

    a. on the overrunning clutch.
    b. on the armature.
    c. by a dust baud.
    d. on the drive housing.

15. The purpose of an "R" terminal on a Delco starter is:

    a. to return excess amounts of electricity to the battery.
    b. to provide high ignition coil output for starting engine.
    c. only important if you have a six volt system.
    d. to act as a safety valve for the armature.

37.04.05.05.

16. If the lights stay bright but there is no cranking action, the problem:

    a. indicates a closed circuit.
    b. may be that of corrosion on the battery cables.
    c. indicates an open circuit.
    d. is that your battery output is low.

17. When diagnosing starter motor problems, you should:

    a. make several preliminary checks in other areas.
    b. first check to see if your brushes are burnt out.
    c. take it out of the car and place it in a clean work area.
    d. examine the starter closely to see if it is hot.

18. In a Chrysler direct drive starter the brush holders are:

    a. not serviced individually.
    b. standard among all types of starter motors.
    c. serviced individually.
    d. lifetime guaranteed.

19. When reassembling, you should lubricate armature shaft and splines:

    a. with graphite.
    b. with SAE 10W-40.
    c. with a light grease.
    d. either a or c above.

37.04.05.05. cont.

20. When diagnosing a starter problem with the lights burning and they go out as the starter switch is closed, it would indicate:

    a. the wiring is reversed on the regulator.
    b. the battery may be over charged.
    c. a poor connection between battery and starter.
    d. the solenoid is grounding out.

UNIT POST TEST ANSWER KEY: STARTING SYSTEMS A

LAP .01

1. c
2. d
3. c
4. d
5. d

LAP .02

6. b
7. b
8. d

LAP .03

~~9. c~~
10. d

LAP .04

11. c
12. a
13. b
14. d
15. b

LAP .05

16. c
17. a
18. a
19. d
20. c

Student: _____ File Code: 37.04.05.00.C1-2 (B)

Date: _____ Date Published: 6/21/77

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: STARTING SYSTEMS (B)

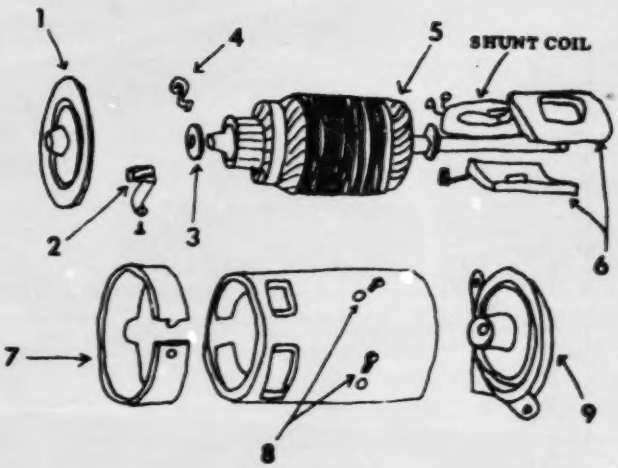
37.04.05.01

1. In the diagram, what is number 3?

   a. drive pinion
   b. coil
   c. dust seal
   d. thrust washer

2. In the diagram, what is number 5?

   a. coil
   b. frame
   c. ring pinion gear
   d. armature



3. In the diagram*, what is number 9?

   a. brush end plate
   b. rear end plate
   c. front end plate
   d. thrust washer plate

4. In an armature loop, each side of the 2-sided loop:

   a. will set up a magnetic field and will have attracting fields
   b. will be insulated with a rubber mount
   c. will set up a magnetic field and will have no charge or be neutral
   d. will set up a magnetic field and each side will have opposing fields

5. When the starter motor armature begins to turn, the starter gear:

   a. moves out of its magnetic field into another field
   b. remains in a neutral position
   c. moves out and engages the ring gear
   d. releases from the flywheel

37.04.05.02

6. When the solenoid switch chatters, it is a sign of:

   a. too much electricity going through the circuit
   b. a bad voltage regulator
   c. reversed wiring on the solenoid
   d. a discharged battery

*Adapted from Auto Mechanic Fundamentals, Stockel, Goodheart-Wilcox, 1974, p 393, Fig. 16-76.

37.04.05.02 cont.

7. The winding(s) in a solenoid switch:

   a. regulate the flow of electricity from the generator
   b. produce a magnetic field
   c. doesn't produce a magnetic field
   d. acts as a ground

8. A 12 volt solenoid switch is energized by the battery through:

   a. a plunger in the starting motor
   b. a separate starting switch
   c. a separate winding in the armature
   d. voltage regulator

37.04.05.03

9. With the bendix type drive in a starter, incomplete engagement of the pinion with the ring gear is:

   a. the reason they made split collars for starters
   b. allowable because of the end play in the pinion shaft
   c. cannot be adjusted
   d. a common cause of tooth damage

37.04.05.04

10. The purpose of an "R" terminal on a Delco starter is:

   a. to return excess amounts of electricity to the battery
   b. to provide high ignition coil output for starting engine
   c. only important if you have a six volt system
   d. to act as a safety valve for the armature

11. On a Delco Remy starter with enclosed shift lever, the solenoid is attached:

   a. on the overrunning clutch
   b. on the armature
   c. by a dust baud
   d. on the drive housing

12. The Delco Remy starter with enclosed shift lever has an overruning clutch:

   a. which is exposed to weather elements
   b. which is operated by a solenoid
   c. which keeps the pinion gear engaged with flywheel
   d. and is the only starter that has one

13. The commutator may be cleaned by:

   a. 00 sand paper
   b. washing it with a light solvent
   c. emery cloth
   d. a wire brush

37.04.05.04 cont.

14. Prior to installing an assembled starter, you should:

    a. paint it
    b. make it water proof
    c. bench test it
    d. check your wiring on your coil

37.04.05.05

15. When diagnosing a starter problem with the lights burning and they go out as the starter switch is closed, it would indicate:

    a. the wiring is reversed on the regulator
    b. the battery may be over charged
    c. a poor connection between battery and starter
    d. the solenoid is grounding out

16. When reassembling, you should lubricate armature shaft and splines:

    a. with graphite
    b. with SAE 10W-40
    c. with a light grease
    d. either a or c above

17. In a Chrysler direct drive starter the brush holders are:

    a. not serviced individually
    b. standard among all types of starter motors
    c. serviced individually
    d. lifetime guaranteed

18. When diagnosing starter motor problems, you should:

    a. make several preliminary checks in other areas
    b. first check to see if your brushes are burnt out
    c. take it out of the car and place it in a clean work area
    d. examine the starter closely to see if it is hot

19. If the lights stay bright but there is no cranking action, the problem:

    a. indicates a closed circuit
    b. may be that of corrosion on the battery cables
    c. indicates an open circuit
    d. is that your battery output is low

UNIT POST TEST ANSWER KEY: STARTING SYSTEMS (B)

LAP 01

1. D
2. D
3. C
4. D
5. C

LAP 02

6. D
7. B
8. B

LAP 03

9. D

LAP 04

10. B
11. D
12. B
13. A
14. C

LAP 05

15. C
16. D
17. A
18. A
19. C

Student: _____ File Code: 37.04.05.00.C1-2 (C)

Date: _____ Date Published: 6/21/77

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: STARTING SYSTEMS (C)

37.04.05.01

1. In an armature loop, each side of the 2-sided loop:

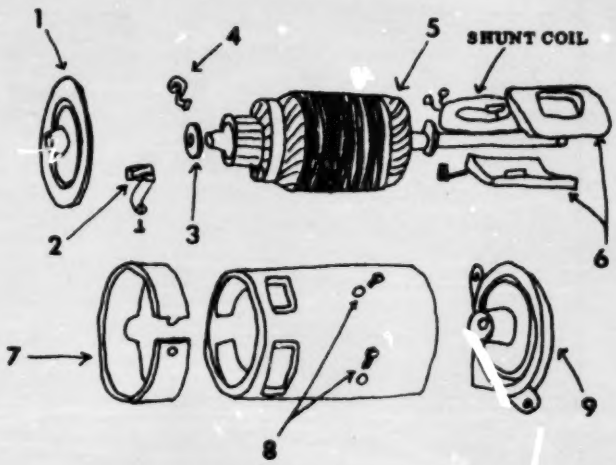
   a. will set up a magnetic field and will have attracting fields
   b. will be insulated with a rubber mount
   c. will set up a magnetic field and will have no charge or be neutral
   d. will set up a magnetic field and each side will have opposing fields

2. In the diagram, what is number 3?

   a. drive pinion
   b. coil
   c. dust seal
   d. thrust washer

3. In the diagram, what is number 5?

   a. coil
   b. frame
   c. ring pinion gear
   d. armature



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5. When the starter motor armature begins to turn, the starter gear:

   a. moves out of its magnetic field into another field
   b. remains in a neutral position
   c. moves out and engages the ring gear
   d. releases from the flywheel

37.04.05.02

6. A 12 volt solenoid switch is energized by the battery through:

   a. a plunger in the starter motor
   b. a separate starting switch
   c. a separate winding in the armature
   d. voltage regulator

*Adapted from Auto Mechanic Fundamentals, Stockel, Goodheart-Wilcox, 1974, p. 393, Fig. 16-76.

37.04.05.02 cont.

7. When the solenoid switch chatters, it is a sign of:

   a. too much electricity going through the circuit
   b. a bad voltage regulator
   c. reversed wiring on the solenoid
   d. a discharged battery

8. The winding(s) in a solenoid switch:

   a. regulate the flow of electricity from the generator
   b. produce a magnetic field
   c. doesn't produce a magnetic field
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37.04.05.03

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   a. the reason they made split collars for starters
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37.04.05.04

10. The commutator may be cleaned by:

   a. 00 sand paper
   b. washing it with a light solvent
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   d. on the drive housing

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   a. paint it
   b. make it water proof
   c. bench test it
   d. check your wiring on your coil

37.04.05.04 cont.

14. The Delco Remy starter with enclosed shift lever has an overrunning clutch:

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    b. which is operated by a solenoid
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    d. and is the only starter that has one

37.04.05.05

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    c. indicates an open circuit
    d. is that your battery output is low

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    c. take it out of the car and place it in a clean work area
    d. examine the starter closely to see if it is hot

18. When diagnosing a starter problem with the lights burning and they go out as the starter switch is closed, it would indicate:

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    b. the battery may be over charged
    c. a poor connection between battery and starter
    d. the solenoid is grounding out

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    a. not serviced individually
    b. standard among all types of starter motors
    c. serviced individually
    d. lifetime guaranteed

UNIT POST TEST ANSWER KEY: STARTING SYSTEMS (C)

LAP 01

1. D
2. D
3. D
4. C
5. C

LAP 02

6. B
7. D
8. B

LAP 03

9. D

LAP 04

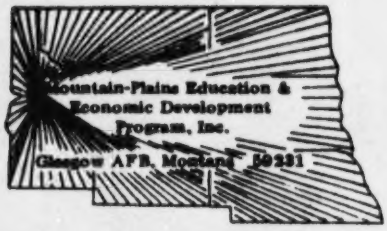
10. A
11. B
12. D
13. C
14. B

LAP 05

15. C
16. D
17. A
18. C
19. A

Student: _____ File Code: 37.04.05.00.B1-5

Date: _____ Date Published: 3/4/76



Family Pay Number: _____ Sex: M F (Circle 1)

UNIT PERFORMANCE TEST: STARTING SYSTEMS

OBJECTIVE 1:

Test Battery.

OBJECTIVE 2:

Overhaul starter.

OBJECTIVE 3:

Inspect starting system wiring.

TASK:

The student will be assigned a vehicle on which he must test the battery, overhaul the starter, and inspect starting system wiring.

ASSIGNMENT:

CONDITIONS:

The student may use only those materials provided for the test and perform the test in the auto shop.

RESOURCES:

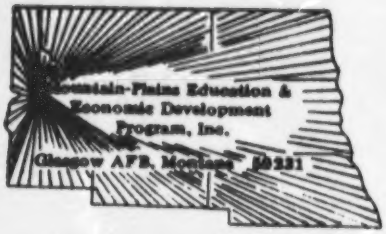
Repair Manuals
Time and Parts Manuals
"Sun" Volt, Amp, Tester
Growler

RESOURCES: (Cont.)

12 Volt Test Light
Repair parts if needed
Fender Covers
Jack
Jack Stands
Combination Ignition wrench set
Combination Wrench Set
Standard Screwdriver Set
Phillips Screwdriver Set
Feeler gauge - .002 through .025 inch
Hex Key Set
Diagonal Cutting Pliers
Needle Nose Plier
1/4" Drive Socket Set
Ratchet - 3" and 6" extensions - 6" flex handle
Ball Peen hammer
Plastic Tip Hammer
Screw Starter
Chisel and Punch Set
5/32" Pin Punch - 3/16" Solid
Gasket scraper
3/8" Drive Ratchet
3" Extension
Spark Plug Socket
6" Extension
Speed Handle
3/8" Drive Socket Set

Student: _____ File Code: 37.04.05.00.B1-5

Date: _____ Date Published: 3/4/76



Family Pay Number: _____ Sex: M F (Circle 1)

PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory_____ Unsatisfactory_____

	CRITERION Met	Not Met
Objective 1:		
1. Service battery.		
Criterion: Clean terminals, clean battery, fill with water.		
2. Load test battery.		
Criterion: Must not fall below 9 volts on 12 volt system or 4.5 volts on 6 volt system.		
3. Charge battery.		
Criterion: Charge battery if load test proves bad.		
Objective 2:		
4. Test starter draw.		
Criterion: Compares to manufacturer's specifications.		
5. Remove and disassemble starter.		
Criterion: Follows service manual procedure and does not damage starter or vehicle.		

	CRITERION Met	Not Met
6. Test for shorts and opens.		
Criterion: Must meet manufacturer's specifications.		
7. Assembles and installs starter.		
Criterion: Must meet manufacturer's specifications.		
8. Tests for starter current draw.		
Criterion. Meets manufacturer's specifications.		
Objective 3:		
9. Inspects starting system wiring.		
Criterion: All wires free of breaks and corrosion and		
meets manufacturer's specifications on		
voltage drop.		
10. Complete test in allotted time.		
Criterion: Meets flat rate time on assigned vehicle.		
The student must satisfactorily complete 8 out of 10 line items		
to pass this test.		

File Code: 37.04.06.00.B1-1

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Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Experience Guide

UNIT: IGNITION SYSTEMS

RATIONALE:

The fundamentals in this Unit will enable you to identify by name and location on an automobile the components of the ignition system. (Repairs and adjustments are covered in 37.07 - Tune-Up.)

PREREQUISITES:

None

OBJECTIVE:

Recognize the components of the ignition system.

RESOURCES:

Printed Materials

Auto Mechanics Fundamentals. Martin W. Stockel, Goodheart-Willcox Company, Inc.

Audio/Visuals

Super 8 Sound Films:

Universal Education and Visual Arts

So Your Engine Won't Start--#7969.
The Magneto--#7970.

Equipment

AVT Systems Super 8 mm Instant Film Loop Player
Automobile with ignition system
Fender covers

Principal Author(s): C. Schramm/W. Osland

GENERAL INSTRUCTIONS:

This Unit consists of two Learning Activity Packages (LAPs). Each LAP will provide specific information for completion of a learning activity.

The general procedure for this Unit is as follows:

(1) Read the first assigned Learning Activity Package (LAP).
(2) Begin and complete the first assigned LAP.
(3) Take and score the LAP test.
(4) Turn in the LAP test answer sheet.
(5) Determine the reason for any missed items on the LAP test.
(6) Proceed to and complete the next assigned LAP in the unit.
(7) Complete all required LAPs for the unit by following steps 3 through 6.
(8) Take the unit tests as described in the Unit LEG "Evaluation Procedures".
(9) Proceed to the next assigned unit.

PERFORMANCE ACTIVITIES:

.01 Fundamentals of the Ignition System
.02 Ignition System Components

EVALUATION PROCEDURE:

When pretesting:

1. The student takes the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of the pretest.
3. The student then takes a unit performance test if the unit pretest was successfully completed.
4. Satisfactory completion of the performance test is meeting the criteria listed on the performance test.

When post testing:

1. The student takes a multiple-choice unit post test and a unit performance test.
2. Successful unit completion is meeting the listed criteria for the performance test.

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package (LAP) listed on your Student Progress Record (SPR).

Student: _____ File Code: 37.04.06.00.B1-2

Date: _____ Date Published: 3/17/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT PRETEST: IGNITION SYSTEMS

37.04.06.01.

1.

2. The ballast resistor bypass is used when:

   a. you get too much current going to the voltage regulator.
   b. you get too much current going to the starter.
   c. cranking the engine.
   d. you get an overload of electricity to the battery.

3. The resistor in an ignition system controls the amount of current reaching the:

   a. voltage regulator.
   b. battery.
   c. coil.
   d. alternator or generator.

4. The advantage of dual points over single points is that:

   a. they increase the open time to which the circuit is exposed.
   b. you can be off on setting of points and car will still be in tune.
   c. at high speeds they will give an adequate spark.
   d. there is none.

5. The primary circuit starts at the battery and flows to the:

   a. voltage regulator.
   b. coil.
   c. resistor.
   d. ignition switch.

37.04.06.02.

6. In the following diagram, identify number 5:

   a. coil.
   b. distributor cam.
   c. condenser.
   d. contact or breaker points.

37.04.06.02. cont.

7. In the following diagram, identify number 9:

   a. plug wires.
   b. spark plugs.
   c. condenser.
   d. coil wires.

8. In the following diagram, identify number 7:

   a. ballast resistor.
   b. distributor.
   c. breaker points.
   d. condenser.

9. In the following diagram, identify number 6:

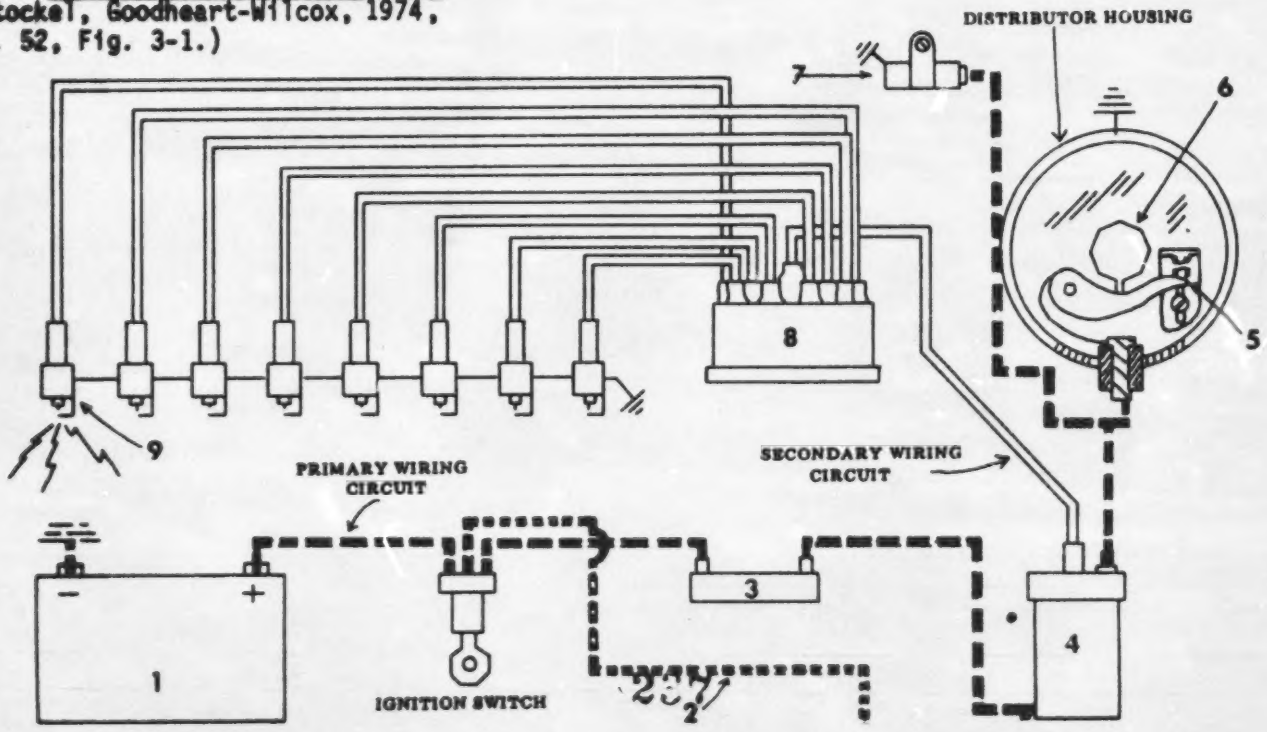
   a. coil.
   b. breaker points.
   c. condenser.
   d. distributor cam.

10. In the following diagram, identify number 3:

   a. spark plug wire.
   b. coil wire.
   c. ballast resistor.
   d. the condenser.

AUTOMOBILE IGNITION SYSTEM *

*(From Auto Mechanics Fundamentals, Stockel, Goodheart-Wilcox, 1974, p. 52, Fig. 3-1.)



UNIT PRETEST ANSWER KEY: IGNITION SYSTEMS

LAP .01

1. c
2. c
3. c
4. c
5. d

LAP .02

6. d
7 b
8. d
9. d
10. c

File Code: 37.04.06.01.81-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Fundamentals of the Ignition System

OBJECTIVE:

Recognize components and proper operation of the ignition system.

EVALUATION PROCEDURE:

Score 80% on LAP study questions.
Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Auto Mechanics Fundamentals, Stockel.

Filmstrips:

Universal Education and Visual Arts

PROCEDURE:

Steps

1. Obtain a text copy and secure a quiet place to study.
2. Read Chapter 3, pages 50 through 71.
3. Study figures 2-28A through 3-46 closely.
4. On separate paper, neatly answer questions 1 through 37 on page 71.
5. Upon completion, give answers to the instructor.
6. Return text to the shelf.
7. View the filmstrips listed in the "RESOURCES".
8. Take and score the LAP test.
9. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.04.06.01.B1-2

Date: _____ Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
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LAP TEST: FUNDAMENTALS OF IGNITION SYSTEMS

1. In a coil, how many windings do you have?

   a. 3
   b. 2
   c. none, it doesn't have any windings.
   d. 1

2. Engines equipped with a magneto do not require a:

   a. battery.
   b. coil.
   c. secondary wires.
   d. distributor.

3. Contact points are made of:

   a. aluminum.
   b. tungsten steel.
   c. spring steel.
   d. stainless steel.

4. The central core of a coil is constructed of:

   a. porcelain.
   b. lead.
   c. special laminated iron.
   d. carbon crystals.

5. The ignition system is divided into how many separate circuits?

   a. 2
   b. 4
   c. 1
   d. 3

6. The primary circuit starts at the battery and then flows to the:

   a. ignition switch.
   b. voltage regulator.
   c. resistor.
   d. coil.

7. The cam angle is important because the longer the points are closed the:

   a. less chance you get for the windings to build up a good spark.
   b. greater the chance of cutting the voltage to your battery.
   c. greater the magnetic build up of the primary windings.
   d. easier it is to float your points and arc them.

8. To break the coil operation momentarily, you have:

   a. diodes.
   b. an ignition switch.
   c. breaker points.
   d. a voltage regulator.

9. The resistor in an ignition system controls the amount of voltage reaching the:

   a. battery.
   b. voltage regulator.
   c. coil.
   d. alternator or generator.

10.

LAP TEST ANSWER KEY: FUNDAMENTALS OF IGNITION SYSTEMS

1. b
2. a
3. b
4. c
5. a
6. a
7. c
8. c
9. c
10. a

File Code: 37.04.06.02.B1-0

Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Ignition System Components

OBJECTIVE:

Identify the ignition system components used on an automobile.

EVALUATION PROCEDURE:

Score 80% on LAP study questions.
Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Automobile ignition system
Fender covers

PROCEDURE:

Steps

1. **Place fender covers.**
2. **Without any aids, record the proper names of each ignition component as they are seen.**
3. **When list is completed, name and point out each of the components to the instructor.**
4. **Take and score the LAP test.**
5. Upon successful completion of the LAP test, ask the instructor for a copy of Unit Post Test 37.04.06. Answer all of the questions and return the test to the instructor for evaluation.
6. Upon successful completion of unit test, proceed to the next unit.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.04.06.02.B1-2

Date: _____ Date Published: 3/4/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

LAP TEST: IGNITION SYSTEMS COMPONENTS

1. In the following diagram, identify number 6:

   a. breaker points.
   b. distributor cam.
   c. condenser.
   d. coil.

2. In the following diagram, identify number 9:

   a. condenser.
   b. plug wires.
   c. spark plugs.
   d. coil wires.

3. In the following diagram, identify number 4:

   a. distributor housing.
   b. condenser.
   c. ignition coil.
   d. distributor cap.

4. In the following diagram, identify number 2:

   a. distributor wire.
   b. secondary wiring circuit.
   c. resistor bypass.
   d. condenser relay.

5. In the following diagram, identify number 8:

   a. distributor housing.
   b. distributor cap.
   c. condenser.
   d. coil.

6. In the following diagram, identify number 3:

   a. ignition coil.
   b. breaker points.
   c. condenser.
   d. ballast resistor.

7.

8. In the following diagram, identify number 5:

   a. contact or breaker points.
   b. condenser.
   c. coil.
   d. distributor cam.

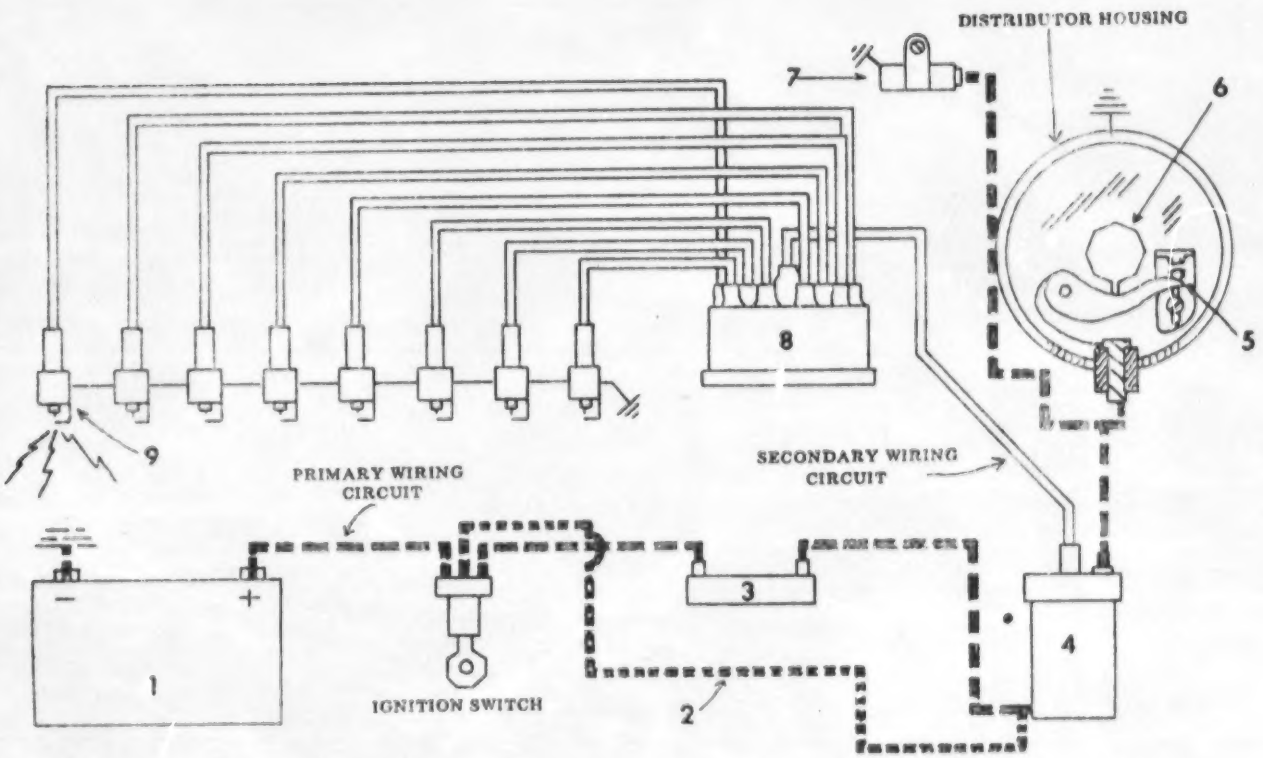
9. In the following diagram, identify number 7:

   a. breaker points.
   b. ballast resistor.
   c. condenser.
   d. distributor.

10. In the following diagram, identify number 1:

   a. frame.
   b. voltage regulator.
   c. battery.
   d. distributor.

AUTOMOBILE IGNITION SYSTEM *



* (From Auto Mechanics Fundamentals, Stockel, Goodheart-Wilcox, 1974 p. 52, Fig. 3-1.)

LAP TEST ANSWER KEY: IGNITION SYSTEMS COMPONENTS

1. b
2. c
3. c
4. c
5. b
6. d
7. [redacted]
8. a
9. c
10. c

Student: _____ File Code: 37.04.06.00.C1-2

Date: _____ Date Published: 10/4/77

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: IGNITION SYSTEMS (A)

37.04.06.01

1. In a coil, how many windings do you have?

   a. 2
   b. 1
   c. none, it doesn't have any windings
   d. 3

2. In modern cars, the voltage available at the spark plug usually exceeds:

   a. 20,000 volts.
   b. 50,000 volts.
   c. 120,000 volts.
   d. 210,000 volts.

3. The cam angle is important as the longer the points are closed the:

   a. easier it is to float your points or arc them.
   b. greater the chance of cutting the voltage to your battery.
   c. less chance you get for the windings to build up a good spark.
   d. greater the magnetic buildup of the primary windings.

4. Engines equipped with a magneto do yout require a:

   a. battery.
   b. transistor to operate or run.
   c. coil.
   d. distributor.

5. To break the coil operation mementarily, you have:

   a. breaker points.
   b. a voltage regulator.
   c. diodes.
   d. an ignition switch.

37.04.06.02

6. In the following diagram, identify number 3:

   a. breaker points.
   b. ballast resistor.
   c. ignition coil.
   d. condenser.

37.04.06.02 (continued)

7. In the following diagram, identify number 2:

   a. resistor bypass.
   b. secondary wiring cicuit.
   c. condenser relay.
   d. distributor wire.

8. In the following diagram, identify number 1:

   a. distributor.
   b. battery.
   c. frame.
   d. voltage regulator.

9. In the following diagram, identify number 4:

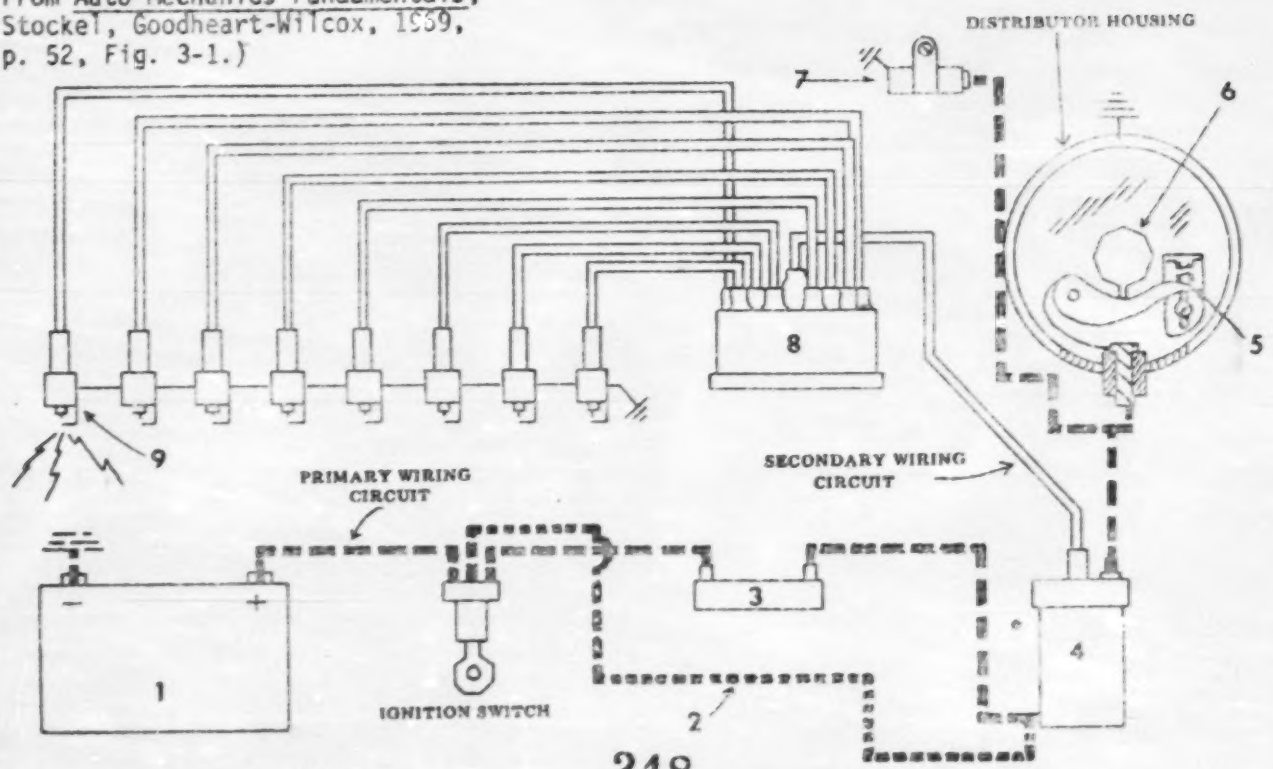
   a. condenser.
   b. distributor housing.
   c. distributor cap.
   d. ignition coil.

10. In the following diagram, identify number 8:

    a. distributor housing.
    b. distributor cap.
    c. condenser.
    d. coil.

AUTOMOBILE IGNITION SYSTEM *

* (From Auto Mechanics Fundamentals, Stockel, Goodheart-Wilcox, 1969, p. 52, Fig. 3-1.)



UNIT POST TEST ANSWER KEY: IGNITION SYSTEMS 4

LAP .01

1. a
2. a
3. d
4. a
5. a

LAP .02

6. b
7. a
8. b
9. d
10. b

Student: _____ File Code: 37.04.06.00.C1-2 (B)

Date: _____ Date Published: 6/21/77

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: IGNITION SYSTEMS (B)

37.04.06.01

1. To break the coil operation momentarily, you have:

   a. breaker points
   b. a voltage regulator
   c. diodes
   d. an ignition switch

2. Engines equipped with a magneto do not require a:

   a. battery
   b. transistor to operate or run
   c. coil
   d. distributor

3. The came angle (dwell angle) is important as the longer the points are closed the:

   a. easier it is to float your points or arc them
   b. greater the chance of cutting the voltage to your battery
   c. less chance you get for the windings to build up a good spark
   d. greater the magnetic buildup of the primary windings

4. In modern cars, the voltage available at the spark plug usually exceeds:

   a. 20,000 volts
   b. 50,000 volts
   c. 120,000 volts
   d. 210,000 volts

5. In a coil how many windings do you have?

   a. 2
   b. 1
   c. none, it doesn't have any windings
   d. 3

37.04.06.02

6. In the following diagram, identify number 8:

   a. distributor housing
   b. distributor cap
   c. condenser
   d. coil

37.04.06.02 cont.

7. In the following diagram, identify number 4:

   a. condenser
   b. distributor housing
   c. distributor cap
   d. ignition coil

8. In the following diagram, identify number 1:

   a. distributor
   b. battery
   c. frame
   d. voltage regulator

9. In the following diagram, identify number 2:

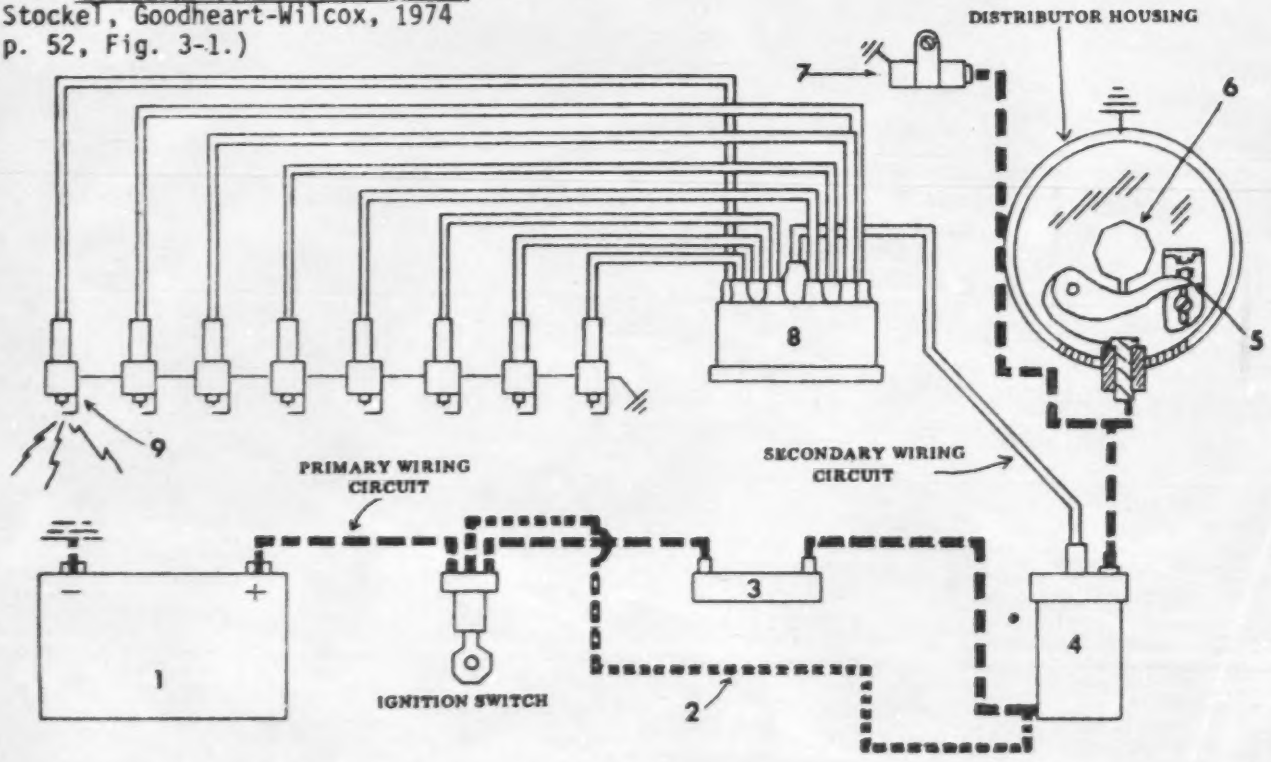
   a. resistor bypass
   b. secondary wiring circuit
   c. condenser relay
   d. distributor wire

10. In the following diagram, identify number 3:

    a. breaker points
    b. ballast resistor
    c. ignition coil
    d. condenser

AUTOMOBILE IGNITION SYSTEM *

* (From Auto Mechanics Fundamentals, Stockel, Goodheart-Wilcox, 1974 p. 52, Fig. 3-1.)



UNIT POST TEST ANSWER KEY: IGNITION SYSTEMS (B)

1. A
2. A
3. D
4. A
5. A
6. B
7. D
8. B
9. A
10. B

Student: _____ File Code: 37.04.06.00.C1-2 (C)

Date: _____ Date Published: 10/3/77

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: IGNITION SYSTEMS (C)

37.04.06.01

1. Engines equipped with a magneto do not require a:

   a. battery.
   b. transistor to operate or run.
   c. coil.
   d. distributor.

2. The cam angle (dwell angle) is important as the longer the points are closed the:

   a. easier it is to float your points or arc them.
   b. greater the chance of cutting the voltage to your battery.
   c. less chance you get for the windings to build up a good spark.
   d. greater the magnetic buildup of the primary windings.

3. In a coil how many windings do you have?

   a. 2
   b. 1
   c. none, it doesn't have any windings
   d. 3

4. To break the coil operation mementarily, you have:

   a. breaker points.
   b. a voltage regulator.
   c. diodes.
   d. an ignition switch.

5. In modern cars, the voltage available at the spark plug usually exceeds:

   a. 20,000 volts.
   b. 50,000 volts.
   c. 120,000 volts.
   d. 210,000 volts.

37.04.06.02

6. In the following diagram, identify number 2:

   a. resistor bypass.
   b. secondary wiring circuit.
   c. condenser relay.
   d. distributor wire.

37.04.06.02 (continued)

7. In the following diagram, identify number 4:

   a. condenser.
   b. distributor housing.
   c. distributor cap.
   d. ignition coil.

8. In the following diagram, identify number 8:

   a. distributor housing.
   b. distributor cap.
   c. condenser.
   d. coil.

9. In the following diagram, identify number 1:

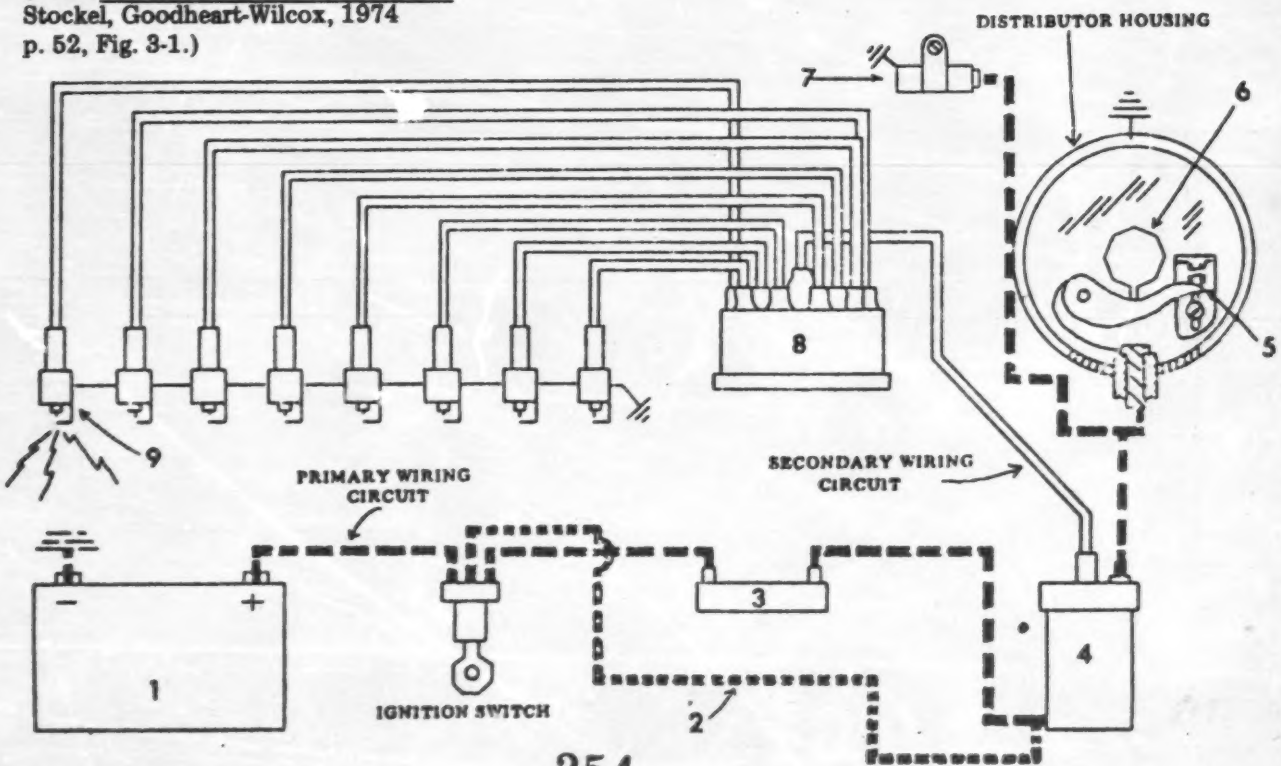
   a. distributor.
   b. battery.
   c. frame.
   d. voltage regulator.

10. In the following diagram, identify number 3:

    a. breaker points.
    b. ballast resistor.
    c. ignition coil.
    d. condenser.

AUTOMOBILE IGNITION SYSTEM *

* (From Auto Mechanics Fundamentals, Stockel, Goodheart-Wilcox, 1974 p. 52, Fig. 3-1.)



UNIT POST TEST ANSWER KEY: IGNITION SYSTEMS (C)

1. A
2. D
3. A
4. A
5. A
6. A
7. D
8. B
9. B
10. B